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Advance Notice by the Institute of Petroleum

PETROLEUM MEASUREMENT MANUAL

The Institute of Petroleum Sub-Committee responsible for the standardization of procedure and equipment for the sampling and measurement of bulk quantities of liquid petroleum products has, for some time now, been actively engaged on the preparation of a Manual on this important subject.

It is expected that this Manual, which will contain over 200 pages, will be on sale at the end of May 1951. Further details of its contents, price, etc., will be announced later, but it may be said now that the Manual will comprise the following six parts covering the following aspects of this important subject:—

Tank Calibration.—Calibration of vertical and horizontal riveted and welded tanks by strapping and internal measurement. Floating roof tanks. Bottom calibration. Allowance for tilt. Calculation of tank tables. Apparatus and equipment specifications.

Oil Gauging.—Methods and procedure for gauging all types of bulk storage and transport containers, including tankers, by dipping and ullaging. Measurement by gauge glasses and other special equipment. Measurement of free water and sludge. Use of positive displacement meters. Apparatus specifications.

Sampling.—Quantitative sampling methods for liquid petroleum products in all types of storage including pipelines, tankers, etc. Apparatus specifications.

Temperature Measurement.—Conventional methods of temperature measurement for heated and unheated liquid petroleum products in all types of non-pressure storage including tankers, etc. Special methods for pressure storage and pipelines. Apparatus specifications.

Specific Gravity.—Specific gravity and density determinations of all liquid petroleum products by hydrometer and pycnometer. Apparatus specifications.

Calculation of Oil Quantities.—Recommended methods for calculating quantities from the measurements made in accordance with the procedures laid down above.

Each part has been so written that all the procedures included are applicable to either the Imperial or Metric systems of measurement. The book will be adequately illustrated and full specifications for the recommended apparatus and equipment will be given.

This I.P. publication, which was prepared in close collaboration with the American Society for Testing Materials, will form a companion volume to the books of Petroleum Measurement Tables now under joint production by the Institute and the A.S.T.M.

The adoption of the procedures recommended in the Institute's Manual will undoubtedly enable the closest possible correlation to be obtained in calculated quantities involved in both national and international petroleum transactions.

COUNCIL, 1950–51

PRESIDENT

C. A. P. Southwell, M.C., B.Sc.

THE INSTITUTE OF PETROLEUM

A MEETING of the Institute of Petroleum was held at Manson House, 26 Portland Place, London, W.1, on Wednesday, October 11, 1950, at 5.30 p.m., the President, Mr C. A. P. Southwell, M.C., B.Sc., in the Chair.

The Minutes of the preceding meeting, held on September 13, 1950, were read, confirmed, and signed.

THE GENERAL SECRETARY (D. A. Hough) announced the names of members elected since the last Ordinary General Meeting, and particulars of the next Ordinary General Meeting, to be held on November 8, 1950.

THE PRESIDENT: I have now the very pleasant privilege of introducing our lecturer to-night, Mr Vernon Smith. In Mr Vernon Smith we have a man of wide experience of the problem on which he is about to talk. He is a director of Shell Française and also vice-chairman of committees in the International Chamber of Commerce and has had a great deal of experience of the European petroleum problems.

It gives me personally very great pleasure to introduce him, for when in 1938 he was the managing director of the Shell organization in Australia, I was also in that country and had many talks with him.

VERNON SMITH, before presenting his paper, said: I am grateful for the opportunity to talk to you on a subject in which I have been very interested. I left Australia at the end of 1944, and have since spent six years in Europe, principally in France. I have seen a great miracle happen—it is no exaggeration to use that term—the extraordinary recovery which has taken place in Europe since 1945. It is not only a physical, but a psychological, recovery. When I went to France in 1945, not only was there dire want and general chaos, the transport system shattered, and so on, but amongst the people on the Continent there was also a feeling of despair and frustration—something which I have not noticed here. The miracle that has taken place has been the change from conditions of under-nourishment to relative plenty and, what I think is even more important, there has been a change from a feeling of hopelessness to that of growing confidence which we see to-day.

PETROLEUM AND EUROPEAN RECOVERY

By Vernon Smith

The economic problems facing Europe at the close of the second world war were of almost unparalleled magnitude and complexity.

Within five years the majority of these problems had been surmounted, and in 1949 the countries of Western Europe had recovered and, in many cases, surpassed their pre-war levels of industrial production and general economic activity.

This paper describes the indispensable contribution of the oil industry to this remarkable achievement and demonstrates the growing awareness in Europe of the value of oil as a source of energy vital to continued economic development.

The Contribution of Oil to the General Economic Recovery of Europe

The oil industry's achievement in increasing the volume of oil supplies to meet the unprecedented demands of the post-war period has been as remarkable as the recovery of Europe itself. In the face of its own formidable post-war problems the oil industry has succeeded in meeting the varied requirements of an economy in which industrial production in 1949 was 15 per cent higher than before the war, and in which agricultural production, in spite of the ravages of war and bad seasons, had virtually regained pre-war levels. The lesson of the period is at once a tribute to the tenacity of European countries and to the enterprise and adaptability of the oil industry.

The demands of six years of total war left Europe in 1945 with most complicated economic problems. Industrial production had fallen to less than half the level before the war and, in Germany, had come to a standstill. Agricultural production was down to little more than 70 per cent of its pre-war level, and the transportation systems of all European countries had suffered acutely from the physical destruction of the war. Moreover, the serious arrears of maintenance and replacement of capital equipment were intensified by the considerable increase in population which had taken place since 1938.

The alarming deficit in Europe's external balance of payments necessitated a rapid revival of production. This in turn depended largely on increasing the availability of fuel supplies in general, and of oil supplies in particular, and although the main emphasis was placed on the rehabilitation of Europe's coal industries, the oil industry has made a remarkable and effective contribution towards the solution of Europe's post-war problems.

Before the war, those European nations which are now within the scope of the Marshall Plan—that is to say, all European countries excluding Spain and those countries which are behind the Iron Curtain—consumed upwards of 30 million tons of oil products. Imports were obtained from the Western Hemisphere (67 per cent), Middle East (24 per cent), Eastern Europe and other sources (9 per cent). Average *per capita* consumption of oil amounted to 32 imperial gallons, which was low compared with the U.S. figure of 334, but high in comparison with most other regions of the world. For all these countries, oil was a vital import for many purposes, in spite of the fact that Western Europe had abundant coal supplies and that in some European countries hydro-electricity was important as an

alternative source of energy. After the war the rapid restoration of oil supplies was particularly necessary on account of coal shortage, the damage sustained by the railways during the war, shortage of rolling stock, and the urgent need to mechanize agriculture in order to reach a higher level of food production.

The consumption of petroleum products by the eighteen member-nations of the Organization for European Economic Co-operation (OEEC) is estimated for 1950 at approximately 50 million tons, compared with the 1938 figure of about 30. Had this increase in demand occurred gradually over the period, the corresponding expansion in oil industry facilities, though considerable, could no doubt have been achieved without difficulty. But success was obtained in the face of the most appalling obstacles resulting from the war : lack of refining capacity, storage and distribution facilities and shipping (due to war losses), the political disturbances in the Far East (Indonesia) and Middle East (culminating in active hostilities between Israel and the Arab countries), grave shortages of essential raw materials especially steel, all kinds of currency difficulties resulting from the non-convertibility of European currencies, and, towering above all, the problem of the dollar deficit.

This has been no ordinary hurdle race, and Western Europe would long since have tripped up had it not been for that most providential intervention, the Marshall Plan, which is now well into its third year of operation. European recovery during the last two and a half years is very much the detailed history of unprecedentedly generous American help without which Europe could not have recovered and the international oil industry would have been impotent to fulfil its role. It will therefore be essential, in even the most rapid survey of the oil industry's contribution during the last five years, to stress the more important factors that have influenced and are still influencing oil policy and planning as a direct result of the combined operations of the Economic Co-operation Administration (ECA) and the OEEC. This will be developed later on in this paper, but it must be borne in mind that even before April 1948, the beginning of Marshall Aid, there had been very important loans and interim aid from the U.S.A. without which, even in its earliest stages, European recovery would have foundered. In this connexion, an impression has sometimes been created that the oil industry receives financial assistance under the Marshall Plan. This, of course, is not the case. It must always be borne in mind that Marshall Aid is extended to Governments and not to industries, and it is the various European Governments who, with the approval of ECA, make the necessary allocation of dollars to the industries concerned, but in all instances the industries affected must pay in their own national currency for all dollar assistance received.

Whilst, therefore, Marshall Aid supplied the dollars without which European recovery would have been impossible, this did not in the slightest degree absolve the industry from initiating its own policy and carrying out its short-term and long-range plans for future expansion and new developments. It is here that the oil industry has shown its vitality, adaptability, and unfailing resource, qualities which have both stimulated and accelerated the revival of Europe's war-shattered economy.

Some of these major activities call for special comment.

Europe's Oil Supplies

Sources of Supply

The greater part of the pre-war oil supplies of Western European countries was obtained from the Western Hemisphere. The big increase in demand for oil products which characterized the post-war period threw into relief the importance of oil imports in relation to European payments, at a time when dollar and other hard-currency outgoings were being rigidly controlled.

At the same time, the transition from war to peace confronted the U.S.A. with its own peculiar difficulties. The anticipation that, with the cessation of hostilities, total consumption would decrease proved entirely erroneous and, though there was some variation in the relative demands for individual products, total consumption continued to grow at such a pace that the

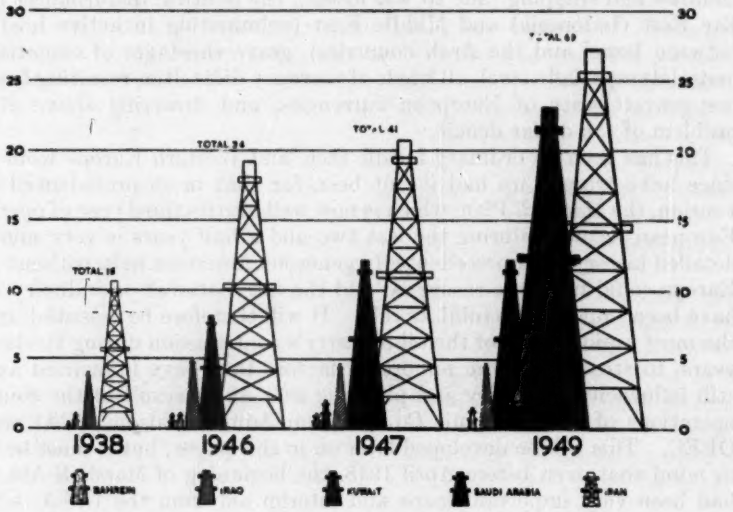

FIG. 1

MIDDLE EAST OIL PRODUCTION (MILLION TONS)

fear of shortages in the U.S.A. culminated in 1948 in the ruling made in Sec. 112 of the Economic Co-operation Act to the effect that "procurement of petroleum and petroleum products . . . shall, to the maximum extent practicable, be made from petroleum sources outside the United States."

These two factors greatly contributed to the shift away from the U.S.A. as a source of supply for Western Europe in the post-war period. The other major source of oil in the Western Hemisphere, Venezuela, had increased production from 28 million tons in 1938 to 47 million tons at the end of the war, but whilst these supplies were in part available against sterling, if they were purchased from U.S.-owned companies they had to be paid for in dollars. In Europe itself, the oil-producing areas of Hungary, Austria, Poland, and Roumania had fallen under Russian control.

Moreover, although the efforts of individual Western European countries

to see oil discovered and developed in their own metropolitan and overseas territories have been attended by considerable success, especially in Germany and the Netherlands (production in these two countries having risen from about ½ million tons in 1938 to just under 1½ million tons in 1949), production in Western Europe as a whole can provide only about 3 per cent of the total needs of Europe.

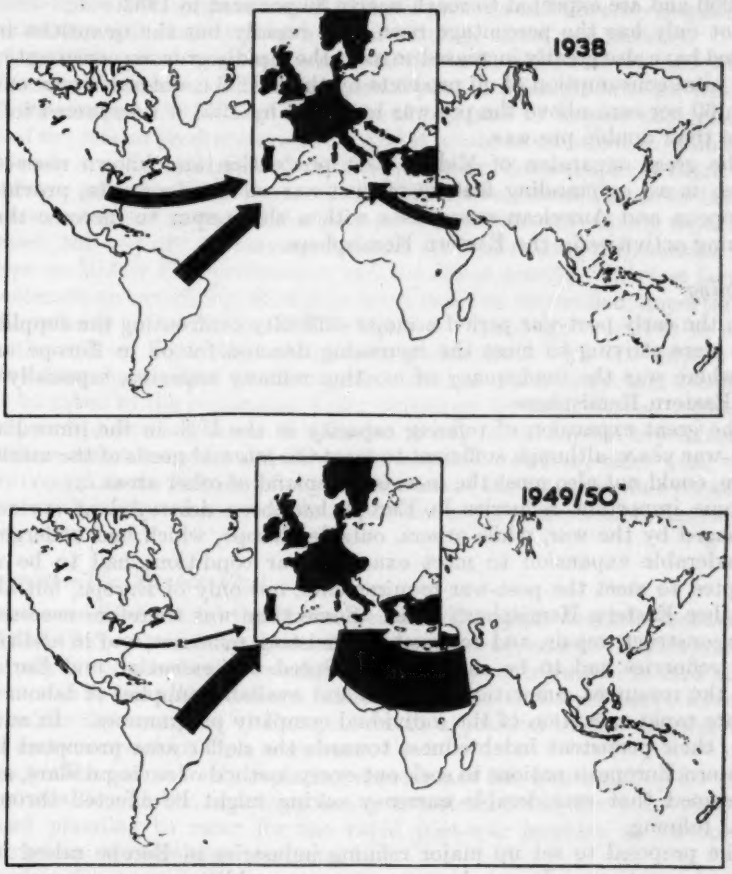

FIG. 2

OEEC COUNTRIES : OIL IN PARTS BY SOURCES (MILLION TONS)

The Middle East, with its greatly increased potential, was destined to be the major source of European supplies in the future. The rapidly rising needs of the U.S. and Latin America gave impetus to the U.S. companies to extend their overseas production in order to meet their market requirements in the Eastern Hemisphere, whilst the Europeans, hampered by payments difficulties, were anxious to draw their oil to the maximum extent from non-dollar sources of supply.

These developments have been reflected in the phenomenal increase in production in the Middle East. (See Fig. 1.)

At the same time, the shift in the balance of supply from the Western Hemisphere to the Middle East is shown in Fig. 2.

Crude oil and products from the Middle East will have risen from 24 per cent by volume of Europe's total supplies in 1938 to over 65 per cent in 1950 and are expected to reach nearly 80 per cent in 1953.

Not only has the percentage risen very rapidly but the quantities imported have also greatly increased to meet the rapidly growing consumption. The total consumption of oil products by the OEEC countries is now more than 60 per cent above the pre-war level and by 1953 it is expected to be more than double pre-war.

The great expansion of Middle East production and known reserves, which is an outstanding feature of post-war oil developments, provided European and American enterprises with a sharp spur to increase their refining activities in the Eastern Hemisphere.

Refining

In the early post-war period a major difficulty confronting the suppliers who were striving to meet the increasing demand for oil in Europe and elsewhere was the inadequacy of existing refinery capacity, especially in the Eastern Hemisphere.

The great expansion of refining capacity in the U.S. in the immediate post-war years, although sufficient to meet the internal needs of the market there, could not also meet the increased demand of other areas.

Some important refineries in Europe had been destroyed or severely damaged by the war, while others, outside Europe, which had undergone considerable expansion to meet exacting war conditions had to be readapted to meet the post-war requirements, not only of Europe, but also of other Eastern Hemisphere areas. Some time was therefore necessary to reconstruct, repair, and readjust the existing refineries, and in addition new refineries had to be constructed. Speed was essential, and Europe had the resources, amenities, services, and available supplies of labour to ensure rapid execution of the individual company programmes. In addition, their persistent indebtedness towards the dollar area prompted the Western European nations to seek out every method of saving dollars, and it seemed that considerable currency saving might be effected through local refining.

The proposal to set up major refining industries in Europe raised important questions. It was, however, no new problem.

In pre-war years local refining had often been considered by the main importing European nations, and in some instances special Government committees had been appointed to examine from all angles, strategic, economic, and social, the desirability or otherwise of refining crude oil locally for domestic consumption.

This is not the occasion for setting out the pros and cons of this highly contentious subject, but it may be stated very briefly that there are, in general, many important economic and commercial reasons for erecting refineries as close as possible to centres of production and shipping the resultant refined products. Much greater flexibility and selection of

required products are ensured, and the final cost to the consumer in an importing country may be lower than if the country undertakes its own refining.

Against this, and apart from the dollar aspects, Governments have been influenced by strategical considerations, such as the risk of over-reliance on availability from certain producing areas subject to political unrest and possible upheavals, by questions of national prestige and the encouragement given to domestic employment by local refining, direct and indirect.

At the outbreak of war, the general practice in Europe, with the exception of France, where national refining was adopted in principle in 1928, was to limit investments for all-out national refining and to import the greater part of the refined products needed. And it would be incorrect to maintain that such a policy had in any way been shown defective as a result of experience gained in the war years. But three new factors had to be taken into account after the war—the urgent need for additional refining capacity to meet the rapidly increasing demand, the increasing dependence of Europe on Middle East production, and the dollar deficit. This last factor has assumed an overriding, though in many cases an unjustified, importance in the refinery plans of the OEEC countries. Although it is true to say that there is an immediate dollar saving associated with the import of crude rather than refined products, this is not the whole story, and account must be taken of the continuing dollar outgoings for maintenance, replacements, and profit remittances in addition to any initial capital expenditure in dollars which may be required. It may be, however, that with the improvement in the balance of payments some of the less economic refinery schemes will be slowed down or abandoned in favour of other more desirable investments.

Transport—The Tanker Fleet

The losses incurred by the tanker fleets of European countries between 1939 and 1945, particularly those of Britain, Norway, and the Netherlands, were very severe, and reflected the all-important contribution, in men and ships, made to the allied victory. The U.S.A. also sustained heavy losses, but, unlike the countries of Europe, was in a position during the war to build many more ships than were sunk.

The problem of not only replacing these losses but also building for the future was formidable, involving heavy investment and the most expert forward planning to cater for the rapid post-war increase in Europe's consumption of petroleum products.

Nowhere has more brilliant success been achieved.

At the beginning of 1948 the European Recovery Programme (ERP) nations had almost wiped out by new construction the losses incurred during the war. Since then a large programme of new construction has greatly increased the units of shipping available now and for the near future. The tanker tonnage of the OEEC countries has increased from 8 million tons in 1945 to 11 million tons in 1949.

The Marshall Plan

Europe at the end of the war was dependent upon dollar sources for more than half its most essential requirements, but in view of the almost complete

lack of dollars it was only by loans and interim aid furnished by the U.S.A., and the subsequent Marshall Plan that supplies could be financed. Without this Aid, or some similar assistance, the recovery of Europe might well have taken different shape and occurred in a different political context.

Through the enactment of the ERP legislation by the U.S. Government

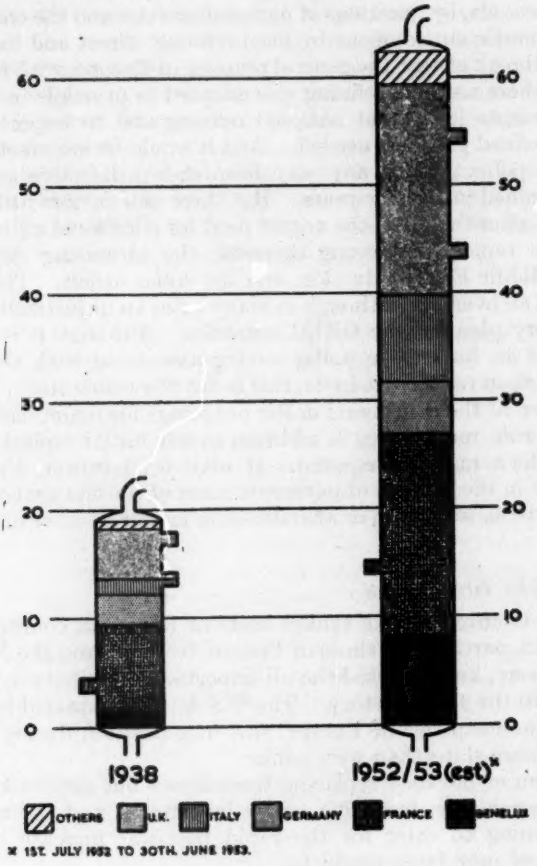

FIG. 3

REFINERY CAPACITY IN OEEC COUNTRIES (MILLION TONS)

in April 1948, a partnership for recovery was set up between the U.S.A. on the one hand and the Western European countries on the other. The Economic Co-operation Administration in Washington and the Organization for European Economic Co-operation in Paris, the two bodies responsible for the implementation of the recovery programmes, have set up different branches or committees to deal with the various financial and economic sectors involved.

The Oil Committee of the OEEC, in close co-operation with the Oil

Division of the ECA, is responsible for all matters connected with the expenditure of Marshall dollars on petroleum imports into Western Europe, and for ensuring that monies spent on oil investments will contribute to the economic well-being of the OEEC countries as a whole and to their ultimate recovery.

It is estimated that nearly 10 per cent of the total Marshall Aid made available to Participating Nations during the first two years of its operation represented supplies of crude oil, refined products, and refining and production equipment. During this period the ECA financed the purchase of no less than $808 million worth of petroleum products, an expenditure which was surpassed by only one other import group—food.

Obviously with Europe still starving for dollars, and with Marshall Aid due to expire in the middle of 1952, one of the outstanding problems has been to take all possible steps now to ensure that future dollar expenditure for essential oil imports is reduced to an absolute minimum. This has been the main task of the Oil Committee of the OEEC.

As already mentioned under "Refining," the Governments of the Participating Nations most concerned had decided on a policy of all-out national refining, with the primary objective of saving dollars, and the OEEC Oil Committee has endeavoured to co-ordinate national programmes of refinery construction in order to ensure continuity in general policy and an avoidance of duplication and overlapping of facilities, thus justifying, from the European standpoint, the demands for such Marshall dollars as are required to implement the various national projects.

There have been many difficulties in the way, and one of the tasks of the Oil Committee has been to discourage the building of refineries of an uneconomic nature or of a capacity that might be out of balance with market requirements.

After a very close examination and a certain amount of pruning, the programme for 1952–53—the end of the Marshall Plan—was accepted by the OEEC and transmitted to Washington. This will bring the total refinery capacity of participating nations to about 60 million tons compared with 19 million tons in 1938—more than three times. This means that except for certain special products such as aviation spirit, Europe is aiming at being able in 1952–53 to refine locally nearly all its requirements of petroleum products.

The Future of Oil in Europe

It is already apparent from the changes which have taken place in the pattern of oil consumption that Europe is rapidly advancing towards the stage at which petroleum will not only be regarded as a useful fuel for transport, lighting, and heating but will also enter into the very texture of Europe's economy.

Europe's New Agricultural Methods

While the industrial production effort of Western Europe since the war has succeeded beyond all expectations, the restoration of production in agriculture remains one of Europe's most pressing economic problems.

Although there has been an increase in agricultural output of 25 per cent in two years, production is still slightly below the pre-war level.

The needs of agriculture are rapidly increasing, and the greater use of oil products in this field is making possible what may go down in history as a twentieth-century agricultural revolution. The number of tractors in use in Western Europe has increased from about 160,000 pre-war to 570,000 in 1949, with the result that the consumption of petroleum products for agricultural purposes has risen from 672,000 tons pre-war to just under 2,500,000 tons in 1949–50. These figures show the remarkable extent to which petroleum, especially in the form of motor gasoline and kerosine, is contributing to the development of European agriculture.

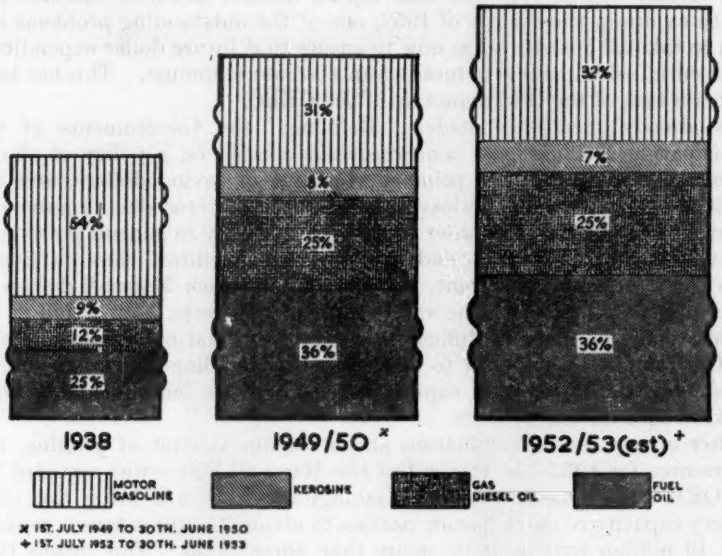

FIG. 4

OEEC COUNTRIES : THE CHANGING PATTERN OF INLAND CONSUMPTION

While the recovery of agricultural production to over 90 per cent of the pre-war level is an achievement, in the circumstances, it can be regarded as only a beginning. Much remains to be done. Western Europe has some twenty million more mouths to feed than pre-war, and there is the desire for higher standards of living to be satisfied. The magnitude of the task, coupled with the high cost of labour and the need for maximum efficiency in production, makes essential a further mechanization of agriculture, and it is believed that, over the next two years, there may be a demand for at least 380,000 new tractors. It is in this field that oil will render perhaps its most important and fundamental service to the European economy.

Transport

Another significant change in the pattern of European oil consumption lies in the increasing use of diesel oil for transport since the war. Gas/diesel

oil requirements of the OEEC countries for these purposes have been estimated at 3 million tons in 1949–50, that is to say 20 per cent more than the *total* gas/diesel oil consumption in these countries before the war. Moreover, it is expected that by 1952–53 road and rail transport requirements of these products will amount to well over 4 million tons, or nearly twice the pre-war *total* consumption figure.

At the same time is envisaged an appreciable increase in total motor gasoline consumption, and a large proportion of this is accounted for by commercial and public transport requirements. It has been estimated that, in five selected countries pre-war figures for motor cars and commercial vehicles were respectively 2,377,900 and 779,000. In 1947, the corresponding figures were 2,268,000 and 1,047,000, and, although the availability of motor cars for home markets has been increasing and

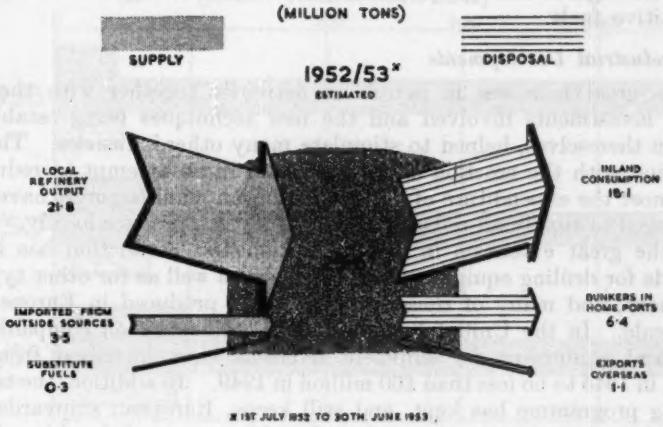

FIG. 5

SUPPLY AND DISPOSAL OF FUEL OIL IN OEEC COUNTRIES

rationing has been virtually ended everywhere, this is unlikely to reverse the trend towards increasing use of gasoline for commercial road purposes. It seems, moreover, that high taxes will continue to act as a deterrent to private consumption.

These notable increases in the volume of road transport in Europe will, of course, increase the need for extensive road maintenance and construction programmes, and in this sector petroleum in the form of bitumen will undoubtedly play its part.

The Outlook for Fuel Oil in Europe

Yet another remarkable example of the important contribution being made by oil towards European recovery is apparent in the increasing use of fuel oil for industrial purposes. The inland consumption of fuel oil in OEEC countries has more than doubled since pre-war, and it is expected to reach 18 million tons by 1952–53. The OEEC Fuel Oil Supply and Disposal Programme for 1952–53 indicates that the increased quantities of fuel oil available as a result of the European refinery expansion pro-

gramme will be more or less in line with requirements when account is taken of the anticipated increase in bunker offtake. This programme, however, is now a year old, and it is probable that adjustments will be made in the light of actual consumption levels.

Despite the striking increases in fuel oil consumption which have already taken place, however, the total consumption of fuel oil in OEEC countries still represents the equivalent of only 4 per cent of their total coal consumption, and is expected to rise to no more than 5 per cent by 1952–53. In certain industries, however, oil has a competitive advantage in terms of efficiency, and this accounts for the efforts European countries are making to modernize their industrial equipment and methods in those sectors of the economy in which oil has special technical advantages which cannot be obtained from coal. Generally speaking, therefore, oil and coal should be regarded as complementary sources of energy rather than as competitive fuels.

New Industrial Developments

These great increases in petroleum activities together with the vast capital investments involved and the new techniques being established have, in themselves, helped to stimulate many other industries. Thus, in connexion with the erection of refineries and in an attempt to reduce to the utmost the expenditure of dollars, European manufacturers have been encouraged to supply all refinery material they can produce locally. Similarly, the great extension in oil exploration and production has led to demands for drilling equipment and pipelines as well as for other types of equipment, and many of these are now being produced in Europe on a large scale. In the United Kingdom alone, orders by oil companies for plant and equipment for shipment overseas have increased from £14 million in 1945 to no less than £60 million in 1949. In addition, the tanker-building programme has kept, and still keeps, European shipyards fully occupied, tankers representing no less than 25 per cent of the ships already built in Europe since the war and 42 per cent of ships under construction. The debt owed by many of the leading heavy industries in their post-war recovery is enormous, and not always fully appreciated.

The oil industry itself has also continued to break new ground, an important example being the production of chemicals from petroleum which has made progress in the U.S.A. and is now being actively developed in Europe. The expansion of refining and the availability of the most up-to-date plants will provide the raw materials for the new petroleum chemical industries which are being established in the United Kingdom, France, and the Netherlands.

Europe's Need for Energy

In total, the present level of oil consumption in Europe is over one and a half times as great as before the war, oil's contribution to Europe's energy consumption having increased from about 8 per cent in 1938 to about 12 per cent in 1949–50.

In 1952–53, when oil is expected to provide some 15 per cent of Europe's energy, total energy consumption in all forms is expected to be about 690 million tons coal-equivalent.

Despite the overall increase in industrial activity, therefore, Europe's consumption of all forms of energy has only increased from 545 million tons coal-equivalent in 1938 to 605 million tons coal-equivalent in 1949–50, while energy consumption in the U.S. in 1949 was about 1100 million tons coal-equivalent—of which over 50 per cent was provided by oil and natural gas.

This comparison gives an indication of the relative levels of economic development and standards of living in the two continents, and provides a measure of the distance which Europe has still to travel along the road of modern industrial and technical progress. Measured against American standards, energy consumption in Europe is still sadly deficient. The

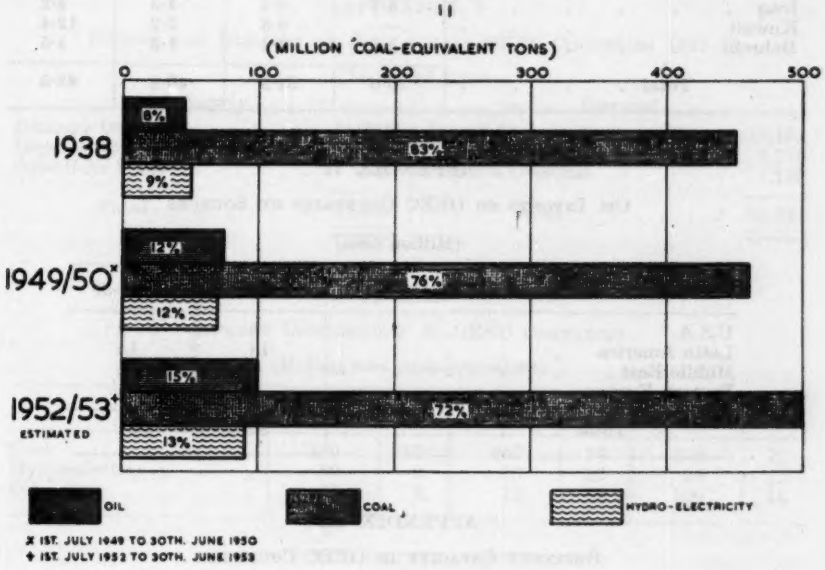

FIG. 6

ENERGY CONSUMPTION IN OEEC COUNTRIES

further increase in industrial and agricultural production and the improvements in all-round efficiency which are essential to bring about full European recovery can be achieved only through a more widespread and more efficient use of energy in all its forms, and recent experience in Europe confirms that the trend is in that direction.

The oil industry contributed in no small way towards winning the war. It can now ensure, even in to-day's difficult conditions, full availability of all essential supplies and speedy transportation, always assuming that the statesmen of Europe persist in their efforts to bring about freer trading conditions, not only within Europe, but also between it and other regions of the world, and to end the irksome controls imposed during the war years which have continued too long. Given these conditions and provided that the relatively low cost of oil in the general price structure is not taken as

an invitation to impose even higher rates of taxation, there can be no doubt that the oil industry in Europe will continue to make an effective contribution to European recovery and development.

APPENDIX I

Petroleum Production in Middle Eastern Countries

(Million tons)

	1938	1946	1947	1949
Iran	10·4	19·5	20·5	27·2
Saudi Arabia	0·1	8·2	12·3	23·2
Iraq	4·4	4·7	4·5	4·2
Kuwait	—	0·8	2·2	12·4
Bahrein	1·1	1·1	1·3	1·5
Total	16·0	34·3	40·8	68·5

APPENDIX II

Oil Imports to OEEC Countries by Sources

(Million tons)

	1938	1949–50
U.S.A.	8	2
Latin America	13	15
Middle East	8	34
Eastern Europe	3	—
Total	32	51

APPENDIX III

Refinery Capacity in OEEC Countries

(Thousand tons)

	1938	1952–53
Austria	625	620
Benelux	1,500	8,258
Denmark	20	30
France	8,000	18,775
Germany	2,800	4,720
Greece	—	400
Italy	1,500	8,115
Norway	50	35
Portugal	—	370
Sweden	60	1,540
Switzerland	—	100
Turkey	—	61
United Kingdom	4,700	19,351
Total	19,255	62,375

APPENDIX IV

ESTIMATED INLAND CONSUMPTION OF MAJOR PETROLEUM PRODUCTS IN OEEC COUNTRIES

(Thousand tons)

	1938	%	1949–50	%	1952–53	%
Motor gasoline	11,999	54	12,052	31	16,389	32
Kerosine	2,060	9	3,261	8	3,572	7
Gas/Diesel Oil	2,551	12	9,862	25	13,048	25
Fuel Oil	5,608	25	14,056	36	18,161	36

APPENDIX V

SUPPLY AND DISPOSAL OF FUEL OIL IN OEEC COUNTRIES 1952–53

(Thousand tons)

Supply		Disposal	
Refinery Output	21,791	Inland Consumption	18,161
Imports from outside sources	3,506	Bunkers in home ports	6,376
Substitute Fuels	340	Exports Overseas	1,100
Total	25,637	Total	25,637

APPENDIX VI

ENERGY CONSUMPTION IN OEEC COUNTRIES

(Million tons coal-equivalent)

	1938	%	1949–50	%	1925–53	%
Coal	450	83	460	76	500	72
Hydro-electricity	50	9	70	12	90	13
Oil	45	8	75	12	100	15

MR. VERNON SMITH concluded : I do not claim to be an expert, but I have a strong feeling that, when the history is written of the period immediately following the end of the second world war, the period from the spring of 1945, when the war virtually ended in Europe, up to the middle of 1950, it will be recorded as a time of unparalleled recovery, and of most intense activity, almost without breaks and almost without inhibitions. That was because the people, once they received help from America and once they really started working, had a real zest in modernizing, as I have seen it in France ; and the extraordinary thing is that, once you get people working with real zeal, the results follow automatically.

There are several dark clouds on the horizon now, and the problems which face the statesmen of Europe are not only that of getting people to work and of feeding them—that still exists—but also of arranging things, if it is humanly possible, so that productivity will not be seriously interfered with, will not be seriously undermined, in spite of the new programme of arma-

ments, the shifting of people from one industry to another, and the call for a very limited man-power in Europe, with the exception of Italy and Germany, for military service. It will be seen during the next year or two to what extent it will be possible to combine those two demands with the maintenance of agricultural and industrial productivity.

THE PRESIDENT : I feel sure that, having heard Mr Vernon Smith, you will agree with the remarks that I made at the beginning. He has given us a very clear picture of the problems in Europe.

DISCUSSION

THE PRESIDENT : First I should like to thank Mr Vernon Smith for his clear review of the European petroleum problems. I feel it is not always appreciated by the men who have been working abroad during the last five years how their work in connexion with the production of crude oil can be related to the problem of providing the food required in European recovery. It seems to me that it would be well to disseminate this information in the clear way in which we have received it from Mr Vernon Smith.

At the end of the first paragraph of the paper Mr Vernon Smith has paid tribute to the enterprise and adaptability of the oil industry. His figures show clearly what has been done during the last five years to improve conditions in Europe.

DR C. M. CAWLEY : I think I can detect a slightly chilly note on the subject of home oil refining. It is stated in the paper that " there are in general many important economic and commercial reasons for erecting refineries as close as possible to centres of production." It seems to me that it might be said with equal truth that there are many important economic and commercial reasons for erecting refineries as close as possible to centres of consumption.

Then again, in connexion with the erection of refineries at centres of consumption, Mr Smith has said that although this does give rise to " an immediate dollar saving associated with the importation of crude rather than refined products, this is not the whole story, and account must be taken of the continuing dollar outgoings for maintenance, replacements, and profit remittances in addition to any initial capital expenditure in dollars which may be required." The implication is that similar dollar outgoings do not apply to refineries erected at centres of production, and this hardly seems to me to be justified.

While appreciating the reasons given by Mr Vernon Smith for the expansion of refining capacity in Europe, I would ask whether the development of modern refining techniques had not had a considerable influence on the economics of home oil refining, especially by reducing refining loss.

I do not wish to press the discussion on home oil refining too far, but merely to make my attitude quite clear. I am content to rejoice that we now have a considerable home oil refining industry and to leave it at that.

I am, however, a little concerned at the possibility—was it only a remote possibility ?—that the present large increase in the refining of oil in the

United Kingdom and in Europe generally might lead to some conflict of interests of the coal and oil industries. I agree that the oil industry and the coal industry are, in general, complementary rather than competitive, but their fields do overlap to some extent, and particularly in connexion with fuel oil. It seems to me that the prospective consumption of 18 million tons of fuel in OEEC countries in Europe is a very large quantity.

In the United Kingdom in 1952 we shall be refining some 20 million tons of crude oil at home refineries, and will therefore be producing some 7 to 8 million tons of fuel oil. The fact that this is a large quantity cannot be disguised by saying that it is only 4 per cent of coal production. I wonder whether we could be quite sure that this amount of fuel oil will be disposed of without any harmful effect on our coal industry, especially having in mind that our export trade will also be influenced by the fairly large-scale production of fuel oil in Europe.

Since reserves of oil in the world are limited, I think it is wrong in the long view that any part of this oil should be employed for purposes for which coal can equally well, or almost equally well, be used. I know that the residual fuel oil produced at refineries must be disposed of, but it seems doubtful whether the solution of this problem can be left wholly to the pressure of economic forces. It is my view that a very good case can be made, on national and technical grounds, for the up-grading of fuel oil by hydrogenation to produce lighter oils. Incidentally, sulphur will be obtained as a valuable by-product. I would like to know whether there is any prospect of such an up-grading process being carried out, and suggest that consideration might be given to the protection of such a process in order to make it economically feasible.

VERNON SMITH : The questions raised by Dr Cawley are extremely relevant. There have been always, and particularly in pre-war days, a whole lot of pros and cons as to whether refineries should be erected at producing centres or close to the main areas of consumption. It will be recalled that, just before the last world war, very important committees were set up to deal with this very question. The economics are difficult, because in moving crude oil over long distances there is a certain wastage of freight; the whole of the crude cannot be utilized; there are refinery losses. Near the important production centres—as at Abadan and other places in the Middle East—very large and very flexible refineries can easily be set up capable of producing a variety of products, and even varieties in the products themselves, which are not easily attainable by home refining, unless the home refineries are sufficiently large and are capable of that flexibility which normally is attained more easily at a producing centre. Those are factors in favour of keeping the refineries near the producing-centres.

Quite honestly, however, we must face the fact that refining in Europe has been given an enormous fillip, probably an exaggerated fillip in some instances, due to the necessity for dollar saving; it means an important gross saving in dollars. There are many counter arguments to show that not as much is saved as is thought will be saved. But it has been said publicly—and I do not entirely agree—that if that gross saving in dollars can be effected, even if there is a slight increase of cost due to less economic

or less efficient running of local and national refineries, in view of the terrible deficit of dollars it is worth while.

I do know that when the OEEC in Paris discussed these various schemes they took into account, first, the dollars that would be saved thereby, for the reason that obviously the aim is to avoid a serious dollar deficit in Europe by 1952–53. France started a national refining industry during the inter-war years, and there is no question of her going back on that. There are also questions of national prestige, of providing useful employment, and of giving a fillip to the technical training of men, when there is a national refining industry.

Thirdly, there was the need of refining capacity to cater for the rapidly growing production in the Middle East; and there are political uncertainties both in the Far East and in countries closer to Europe, for example the Near East, with hostilities between Israel and the Arab States. Undoubtedly many of the countries in Europe have been actuated by the fear of placing absolutely vital refineries, necessary for meeting Europe's future consumption of liquid fuels, in areas subject to serious political difficulties. I think that consideration has weighed.

With regard to the problem of fuel in general, there is still a dearth of available energy in Europe, and I foresee ample demands for increased quantities of coal, fuel oil, and electricity in the future. I feel that, generally speaking, those fuels are complementary. Dr Cawley has mentioned that there may be a waste of a certain quantity of fuel oil; but I think that considerations of price and thermal efficiency should be able to take care of that. The OEEC, in planning the refinery programme, have tried to work out that the residual fuel oil that will be produced will still fit in with the general pattern of the market, without causing any serious dislocation of the market for coal.

I can only say that the fears which Dr Cawley has raised have been expressed in France and in other countries, and during the last six months a very important coal/oil joint committee has been working in the OEEC in Paris, trying to analyse these very problems. That committee has done its best to obtain data from the various countries of Europe—and it is rather difficult to collect worth-while data in some cases—and its findings will have very important repercussions on the oil and coal industries. If economics show that the use of coal is more satisfactory, that it is very expensive to burn residual oil where coal can be used, then by reason of the flexibility in refinery usage the oil can be dealt with by cracking, hydrogenation, or other methods. If it is asked whether we should go to the extreme of asking for a preference to facilitate a market adjustment on these lines, I would say that I do not like preferences of that kind.

O. THORNYCROFT: Mr Vernon Smith has drawn attention to the enormous increase in the consumption of gas oil or diesel oil. It is known that the gasoline engine for agricultural machinery is uneconomical as compared with the diesel engine, and therefore large economies in fuel could be effected if we made a really big effort to develop the diesel-driven tractor in place of the gasoline one. I would ask if he would view with alarm the increase in the demand for diesel oil which would arise if agricultural machinery were gradually converted to use that fuel instead of gasoline?

VERNON SMITH : My answer is that that is very much a matter for the tractor manufacturers; if they could demonstrate without any doubt that a tractor consuming diesel oil was more efficient than one consuming gasoline, and if the agriculturalists who use tractors were similarly convinced, the oil industry would be obliged to adapt itself to the demands. I have been surprised to note how different fuels are used in different countries. I was in Australia and New Zealand, and I would say that 75 to 80 per cent of the tractors in those countries were burning power kerosine; they had a special power kerosine, which was different from that used for illumination. The amount of gasoline used in tractors in those two countries—and Australia has always gone ahead very much with tractors—was very small indeed. When I came to Europe I noticed that power kerosine was little used, particularly in France; the tractors mostly use gasoline.

P. F. MILES : I have been interested in Dr Cawley's remarks on the siting of refineries from the strategic point of view. It seems that very soon the Middle East will have almost a monopoly of the supply of crude oil to Western Europe. Do you not think, that this may present something of a danger? The Middle East has in the past proved a centre of political unrest, and there seems little real indication of a change to a more stable overall position. Is, therefore, this policy of total investment really a safe one?

Secondly, I would like to refer to your point regarding the annual production of 1½ million tons of crude in Western Europe. You will be aware that Austrian production of crude is of the order of 800,000 tons per annum. The whole of Austria including the Russian Zone is receiving OEEC aid; would it not be reasonable to expect at least that a portion of this large production be made available for consumption in Western Europe?

VERNON SMITH : My answer to the first question is that, if 80 per cent comes from the Middle East, and if that is a vulnerable area, then obviously the source of crude is somewhat vulnerable. But there is rather a difference between production of crude and the erection of large, highly expensive, and highly technical refineries. It must be remembered that in the Middle East homes have to be created, often in the midst of deserts and all kinds of facilities provided, at enormous expense, whereas if the population is well trained and well equipped, as is the population of Europe, there is a tremendous incentive to site the refineries where that population exists. I have said that undoubtedly the political situation in the Middle East weighed in the councils of many of the European nations; there must always be a danger, and one would always look for other sources of supply. But the supplies were not available from the U.S.A., the main source of oil, producing very nearly 60 per cent of the world's oil supplies; and even the Americans themselves, whilst giving all their generous aid, asked us not to take oil from the U.S.A. Obviously the thing to do is to provide such strong defensive measures, to re-arm effectively and to provide such efficient military strategy that these problems are reduced so far as they can be reduced.

As far as Austria is concerned, my recollection is that that production is chiefly in the Russian zone, and consequently very little of it filters

through to the non-Russian part of Austria. It is certainly not available for general use by the western European nations; I think most of it is commandeered by the Russians.

A visitor from the United States Embassy said : It was my pleasure to be in Paris shortly after the Marshall Aid plan was discussed, in July 1948; and I was there also early in 1947. I did sense there that defeatism was being overcome.

My primary object in rising is to thank the Institute of Petroleum for having invited my colleagues and myself to this meeting. We do appreciate that invitation, and we have been most interested in all that Mr Vernon Smith has said.

J. S. PARKER : A comment I would make concerns " the desirability or otherwise or refining crude oil locally for domestic consumption." Though Mr Smith has stated that " this is not the occasion for setting out the pros and cons of this highly contentious subject " he has outlined several of the pros, and a previous speaker has outlined several cons. I would support the previous speaker by recording that " there are in general many important economic and commercial reasons for erecting refineries as close as possible to centres of consumption." As a refiner I am by no means clear on what is meant by the statement that " much greater flexibility and selection of required products are ensured " by refining at the source of production. As the question is, however, outside the main cover of this paper, I would not propose to pursue it further. The last statement that " the final cost to the consumer in an importing country may be lower than if the country undertakes its own refining " is, however, one on which comment might be made. The operative word is " consumer." The price to the consumer in the United Kingdom is controlled by the yardstick of the U.S. Gulf price, and has been so controlled as long as I can recollect.

The same price operates whether or not the product or the crude oil is imported from the producing centre. It would appear to be the refiner who takes the rap if his refining operations are out of line with prices and not the consumer, who pays what it would cost to import the product from the U.S. Gulf coast.

VERNON SMITH : With regard to prices, if they are controlled on the basis of the U.S. dollar, the consumer will probably not suffer from any of the economic repercussions. But obviously, if refineries, costing a great deal of money, made a loss by having to sell at a price below the cost of production and refining, they would have to bear that loss, or perhaps a decrease of taxation could be allowed in order to make the refining profitable, in which case the loss would fall on Government revenue. Even that has been suggested.

C. I. KELLY : There are two chief points that interest me and perhaps others. The first hinges on a change of terms—a change from " petroleum " in the title of the paper to " oil " in the text. I think that this focusing of attention on oil, *i.e.*, liquid products normally, unfortunately distracts attention from the contribution that can be made to European recovery by petroleum gases.

It may be that utilization of these hydrocarbon gases, either as liquefied butane and/or propane or as gaseous fuel in industry, may upset the balance of the refinery programme as drawn up by the Oil Committee in Paris; in any case, it would be interesting and helpful to hear something about the Committee's or the OEEC's attitude on this matter, for there may be a significant amount of hydrocarbon gases available which can be distributed fairly easily in the countries inside the Oil Committee's orbit for use outside the oilfields and refineries.

The second point is the lack of reference, in the paper, to lubricating oil. It astonishes me, as one who has been intimately connected with lubricating oil for the past twenty-five years, to encounter once again a paper on Europe's (and the United Kingdom's) requirements of petroleum products in which the classification and terms are so general that either lubricating oil is left out altogether or it is bulked with " other products " and so escapes notice.

Unintentional in many cases, this silence on lubricating oil matters tends to obscure the fundamental importance of lubricants in the life of European countries, most of which are highly industrialized and are becoming more mechanized. The plain-to-all fact is that, whether the fuels be solids, liquids, or gases, the prime movers and other machinery must have lubricants of many qualities, in wide variety, and none should ever be in short supply.

Moreover, if it is the intention of OEEC and the Paris Oil Committee to foster a reasonable self-sufficiency (domestic refining capacity) in European countries, it should include lubricating-oil refining capacity almost as a first consideration.

In special connexion with the United Kingdom's needs, it is the case that during the past few years the amount of domestically-refined lubricating oil has caught up with the amount imported. Moreover, from January to August 1950 the amount of lubes imported was 56 per cent more than the corresponding figure for 1949, whereas the sterling value was twice that for the same period in 1949.

The question of dollar saving is also involved in considering lubricating oil's place in a complete refinery scheme for a European country. Although we have to tackle the balance-of-payments problem, steps taken in this connexion obviously will go contrary to the interests of lubricating oil exporters in the Western Hemisphere, inasmuch as the lubricating oil business is big business. Indeed, a writer in a U.S. oil journal early in 1950 felt that American lubricants were to be the next victims of a British campaign to keep dollar oil products out of the sterling area and make Europe self-sufficient in petroleum ! Why exception should be taken to this, in those terms, is difficult to appreciate, inasmuch as the declared policy of ECA, etc., is exactly that—to promote European self-sufficiency and, I assume, in lube refining capacity also.

The correspondent referred to said that, against the millions and billions, in which terms the oil industry speaks of production, 6000 barrels daily increase in European refinery capacity for lubricating oil (*his* figure for lubricating oil refining capacity expansion in Europe, including the United Kingdom) does not seem to be very important; but, he went on to say, that amount daily will run into millions of dollars a year.

What the United Kingdom appears now to need is an increase in lubricating oil refining capacity of some 400,000 tons a year—which is a mere 5 per cent of the amount of lubricating oil made in the U.S.A. in 1948. This increase now needed is much larger than the 20 per cent deficiency which the OEEC and Paris Oil Committee seem content to allow to remain, after practical expression has been given to published refinery expansion projects in the United Kingdom and other undisclosed projects.

But why leave the United Kingdom and Europe deficient in lubricating oil refining capacity to the extent of 20 per cent? The lubricating oils in that 20 per cent are most probably to be the high-quality, high-priced grades designated somewhat obscurely by the Oil Committee and OEEC as "Special Products."

Is there something so special about them, apart from the high pay-off inherent in them, that makes it impossible for them to be made in the United Kingdom as part of the general expansion of lubricating oil refining capacity? Surely it is obvious that to arrange to have these special lubricating oil products made in the United Kingdom will enable the whole lubricating oil refining programme to be more economical and less likely to involve a trading loss, not only to the lubricating oil refiners, but also to the Treasury in terms of outgoing dollars.

Admittedly it is a rather tricky subject to deal with in public discussion without knowledge of the findings of policy-makers, the Paris Oil Committee's decisions, and other undefined attitudes which condition the OEEC reports. But, in view of the profound importance of lubricating oil, apart from the type of fuel that may be available, in the industrialized countries of Europe, it does seem to me to be a matter well worthy of more emphasis, further details, comment, and discussion.

VERNON SMITH: I thank Mr Kelly very much—not that I can reply to him in any detail; I have said all along that I am not a technical man, nor do I know the technicalities of the subject he raises in the United Kingdom. However, I can quite readily appreciate that lubricating oil could quite easily have been brought into these figures; I can assure you that, in leaving them out, there was no intention on my part to ignore in any way the tremendous importance of lubricating oil and its refining, for the reasons given by Mr Kelly. I am glad he has mentioned the matter, because in so doing he has filled a gap in my paper.

The idea of limiting the figures to the four products was to deal with major trends. The lubricating oil position is very important, but it is difficult to show it in figures of volume, whereas it was fairly easy to show the great increase in the consumption of the four products mentioned; and the inclusion of the lubricating oil figures would have required a considerable expansion of the scope of the paper. I admit candidly that, when we speak of major products, there is no reason why we should exclude lubricating oil, or why the points raised by Mr Kelly should not be given consideration; but I had no sinister intentions.

In connexion with the detailed programmes, Mr Kelly will appreciate that tremendous consideration has been given to lubricating oil refining; each one of the various refinery projects has been examined in detail by the representative committees in Paris, and they are also similarly examined if

there is a demand for Marshall oil. To what extent there is still a gap in respect of lubricating oil I regard as a highly technical question, and I ask Mr Kelly to allow it to pass by this evening because, quite candidly, in drawing up the paper probably I have not given that point sufficient attention.

DR P. H. FRANKEL : I would like to recall the reference to fuel oil as being complementary to other fuels. I am sure we shall all agree that " complementary " is a flexible expression. One of the great problems before the industry will be the increasing difficulty of marketing increased quantities of refinery products in line with the increase of available crude; and the industry should not be indifferent, because it is obvious that only if we manage to create new markets for fuel oil shall we balance the total operations of the industry. I believe the right philosophy of the industry in this matter would be an optimistic one. Assuming that, for reasons beyond our control, cheap coal would not be available, larger and larger demands for products would come within the orbit of the oil industry. To meet this contingency the oil industry will have to adjust its production ideas and its prices and qualities. I think the word " complementary " should be used in an aggressive, not in a complacent, sense.

B. N. DARBYSHIRE : I am not sure that we are quite entitled to pat ourselves on the back. I think we were really rather slow off the mark in this matter of refinery construction. In France, the one country in Europe where they had well-developed refineries before the war due to Government insistence, they were very keen and enthusiastic to build up refinery capacity immediately after the war. That capacity was badly damaged during the war.

VERNON SMITH : Two-thirds was damaged.

B. N. DARBYSHIRE : We in the United Kingdom, on the other hand, were rather slow. Indeed, I recollect that in 1946 certain interests were still putting forward arguments against home refining, and it was not until rather later that the big refinery schemes came into being. So that our programme in fact is well behind that of the French in reaching the stage of completion. I suppose one result of that is that we have been rationed for gasoline for so much longer.

A matter which has not been stressed very much to-night, and which should be mentioned in connexion with a paper of this sort, is that the cost of the products we have been distributing has been rather on the high side, in terms of our own currency at any rate, particularly in view of the fact that the oil we are bringing in to refine here—and we shall bring in more in the future—is produced at very low cost in the Middle East. We have seen a really beautiful series of illustrations this evening. Fig. 1 would have been more interesting if we could also have had a curve showing the cost of production in each of those areas. I think such a curve would be a useful addition to the paper.

That leads me to the point that there appears to be a grave lack of competition in the industry to-day. With the OEEC being encouraged to act as the weeder-out of the smaller refinery schemes which, Mr Smith would

have us believe, do not appear to have the same technical and economic advantages as have some of the larger schemes sponsored by the major companies, it becomes virtually impossible for any new elements to enter the refining and distribution sides of the industry. That is leading to a greater degree of rigidity, and it is quite a big problem, particularly as, so far as we can see, we in Europe are going to be geared to Middle East production, which is itself closely controlled by a very few large companies. I think we have to watch this, because if we cannot show that there is very genuine competition in our industry we shall rightly become subject to control; that may be national control in the countries in which we operate, or it may be international control. The OEEC have already shown certain signs of wanting to impose price control on Middle East Companies; and I think that various organizations, probably not quite so well forward in their set-up as OEEC will have their eyes on the matter. Watching the situation there is the Economic Commission for Europe in Geneva, and there are also the Schuman Plan people dealing with the internationalization of iron, steel, and coal, and maybe they are considering oil as the next step. I think this is something we have to bear in mind. We see comments in the Press about major companies endeavouring to make financial arrangements to retain shares in the market. The idea of a " shared " market should be very repugnant to us all, but perhaps we have grown used to it.

Mr Smith made a very interesting comparison between the consumption of energy in the U.S.A. and in Europe, and stressed the importance of increasing the energy consumption in Europe in order to provide a higher standard of living for European peoples. It is, of course, absolutely essential, but I think it is more likely to be realized if we can get down to rather lower costs of petroleum products. We must remember that petroleum costs in Europe are still based on American prices, plus freight charges from the U.S.A. to the United Kingdom, although we are receiving the petroleum from the Middle East. That is a very vexed question, but I think that on the occasion of this paper we should have it in mind.

I do not wish you to carry the following analogy too far, but perhaps it is one which our American friends might bear in mind. If we could visualize that the Middle West was removed bodily for a little while to the Middle East, and the Middle East to the Middle West, we might soon have a very different price structure. I am sure that if the Middle East became domestically American for a very short time we should see the American Government axe coming into operation to make some genuine competition, and it would have a very beneficial effect on oil prices.

THE PRESIDENT: To conclude this meeting I should like to say how very glad we are to have had this clear exposition of European recovery in relation to petroleum.

We appreciate very much the way in which Mr Vernon Smith has answered a lot of questions. On your behalf I would like to express our very grateful thanks to him, and I would ask you to join with me in expressing our appreciation in the usual way.

(The vote of thanks was warmly accorded, and Mr Vernon Smith briefly responded.)

A METHOD FOR EVALUATING THE OXIDATION STABILITY OF INHIBITED TRANSFORMER OILS

By G. H. Beaven, R. Irving,* and C. N. Thompson* (Associate Fellow)

Summary

A method is described for the evaluation of the oxidation stability of inhibited transformer oils by measurements of their rates of oxygen absorption. Under the experimental conditions described, the oxygen absorption/time curves show well-defined induction periods before the onset of oil oxidation proper, and the consequent formation of appreciable amounts of acid and sludge. The induction period is taken as being an important criterion in the evaluation of inhibited oils, and is considered to be a measure of the susceptibility of an oil to any particular oxidation inhibitor. Data are presented showing: (*a*) the response, to a particular inhibitor, of transformer oils of varying degrees of refinement, (*b*) the response of a particular oil to varying concentrations of inhibitor, and (*c*) the relative effects of different inhibitors. An important result arising from this work is that a correlation has been established between tests involving the use of soluble copper and solid copper catalysts respectively.

Introduction

One of the most important and fundamental properties of a transformer oil is its stability towards oxidation. Whereas the physical properties of an oil (viz, viscosity, volatility, pour point, etc) depend almost entirely upon the choice of feedstock distillate, the chemical and electrical properties (viz., acidity, dielectric strength, D.C. resistivity) are determined principally by the refining treatment to which a particular feedstock is subjected; the oxidation stability depends upon both the choice of feedstock distillate and the refining treatment. A. A. Pollitt [1] has critically reviewed the more important specification test methods for the laboratory evaluation of the oxidation stability of transformer oils.

The principal objections to the present British test, the B.S.I. (Michie) sludge test (B.S. 148 : 1933), may be briefly stated as follows :—

(*a*) The reaction temperature of 150° C is considerably higher than that normally obtaining in service, but is presumably necessary in order that results may be obtainable within an elapsed time of three to four working days.

(*b*) A general tendency for the test to yield results of poor repeatability and reproducibility has been noted in many laboratories.[2,3]

(*c*) No estimations of the sludge formation or acidity development are made during the test but only at its termination. The procedure therefore merely gives a measure of the *amount* of the products of oxidation at a single arbitrary time and not a measure of the *rate* of oxidative deterioration (*i.e.*, the rate of formation of those products). This is a valid objection to any fixed-duration test that may be applied where the oxidation-rate curves of various oils may cross so that the merit-rating of the oils can change according to the duration of the test.

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(*d*) It has been suggested [4] that the B.S.I. test is " unreliable in its application to the transformer oils of the future," viz., inhibited oils. Meaningless results are frequently obtained, because at the end of the " fixed-time " test the oxidation of many inhibited oils has not proceeded beyond the " induction-period " stage; oxidation has virtually not started, and figures for sludge and acidity are frequently found to be nearly zero.

It is clear that any evaluation test for either uninhibited or inhibited transformer oils should measure the rate of oxidation instead of merely giving a knowledge of the relative amounts of sludge and acidity produced during the process. The test described here enables the rate of oxidation to be studied by measurement of the rate of oxygen absorption.* In order to obtain comparable results all tests are extended to the same level of oxygen consumption, namely the absorption of 1000 ml O_2/100 g oil; sludge formation and acidity development are measured at this level. Such a test, in which the course of the reaction is followed by measuring the rate of consumption of oxygen, is clearly of fundamental importance. Not only are the final products of reaction measured but also knowledge is gained of the earlier reactions between hydrocarbons and oxygen, to produce intermediates (*e.g.* peroxides) which decompose to give the familiar products of oxidation. In this respect the test is also suited for a study of the kinetics of oil oxidation and the elucidation of the mechanism by which deterioration occurs.

Although, at the present time, the test is applicable only to the evaluation of the oxidation stability of inhibited oils, it is hoped that suitable variations in the reaction conditions will result in a test suitable for the evaluation of uninhibited products.

Experimental

To achieve the required degree of acceleration, four important experimental variables were fixed as follows :—

1. *The Temperature*

The temperature at which the test is carried out has been fixed at 120° C; this is in conformity with the widely held view that 150° C (the temperature of the B.S.I. sludge test) is too far removed from practice.

2. *The Gas Phase*

Pure oxygen at atmospheric pressure is used as the oxidizing agent. It is considered that the use of an atmosphere of air (as in many specification tests) has no special recommendation, the nitrogen merely serving to dilute the oxygen.

3. *The Liquid Phase*

Oxygen is present in contact with a static oil surface, and the test will therefore be referred to as the " static oxidation test." In order to ensure

* A preliminary account of this work was presented by W. Pohl at the 1948 meeting of the Conférence Internationale des Grands Réseaux Electriques (*Proceedings of 12th Session*, Paris, 1948, **1**, 213). *See also* " Oxidation Stability of Transformer Oils," by A. J. Ham and C. N. Thompson (*J. Inst. Petrol.*, 1950, **36**, 673–83).

that the rate of oxidation is not controlled by the rate of diffusion of oxygen, a relatively thin film of oil of large surface area is used.

4. *The Catalyst*

Solid copper (and iron) is used as a catalyst in many transformer-oil evaluation tests, and although there is no doubt that a solid metallic catalyst such as copper can exert an appreciable effect upon the rate of oxidation, it is by no means certain whether it is expedient to use a catalyst *in this physical state*. It has been shown that the effect of copper in the oxidation of oils is an example of homogeneous catalysis,[5] and thus the effectiveness of a solid catalyst must depend primarily upon its rate of dissolution into the oil (presumably by reaction with acids). As the oxidation proceeds and the concentration of acids increases, the rate of dissolution of copper will also increase and still further accelerate the deterioration. In view of this, and also the fact that oils from transformers occasionally contain so much dissolved copper that they possess a visible greenish colour, it was regarded as justifiable to include a soluble copper catalyst in this test. In Table I, the relative catalytic effects of small amounts of oil-soluble copper (introduced as naphthenates) on the oxidation of a typical transformer oil are tabulated.

TABLE I

The Effect of Copper on the Rate of Oxidation of Oil F

Copper concentration, p.p.m.	Oxygen absorption time (time for absorption of and reaction with 1000 ml O_2/100 g oil), hours.
0	>72
10	8·6
25	5·0
50	2·5
75	1·9
100	1·8
150	1·4
200	1·5
250	1·6
350	1·4
425	1·5
500	1·7
1000	2·1

In all the present work in connexion with the evaluation of inhibited oils a standard concentration of 100 parts copper per million of oil/catalyst blend is used. From the catalyst-response curve given in Fig. 1 it will be seen that this concentration is about the lowest one giving a maximum catalytic effect. Similar types of curves have been obtained for other transformer oils, in each case a maximum catalytic effect occurring at a copper concentration of about 100 p.p.m. The catalyst used is copper naphthenate prepared from a distilled, de-oiled fraction of naphthenic acids. Catalysts containing from 7 to 12 per cent weight copper have been found to have identical catalytic effects when dissolved in oil in appropriate amounts to yield equal copper concentrations.

The apparatus used is shown in Figs. 2*a* and 2*b*; it consists essentially

of : (*a*) a 100-ml Erlenmeyer conical flask containing the oil, inhibitor, and catalyst, (*b*), a water-jacketed absorption tube containing soda-lime

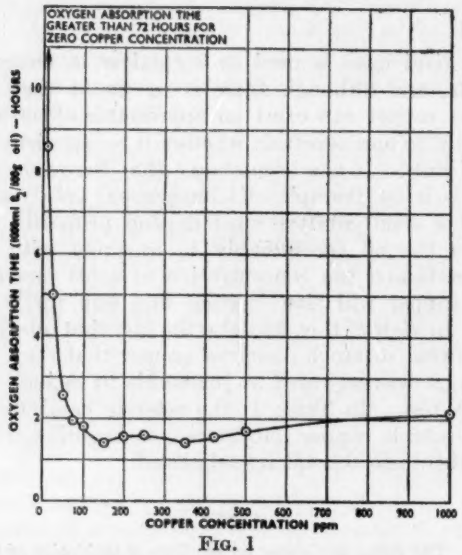

FIG. 1

EFFECT OF CONCENTRATION OF SOLUBLE COPPER ON RATE OF OXIDATION OF TRANSFORMER OIL F

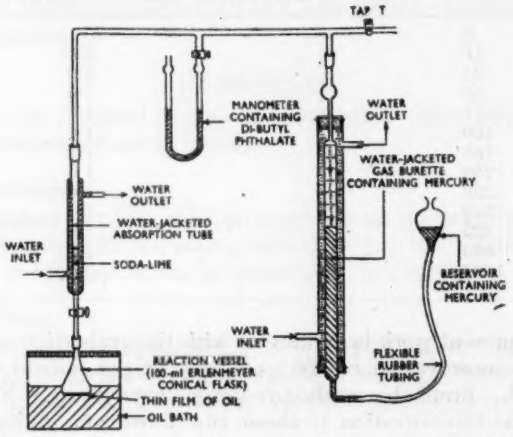

FIG. 2A

OXYGEN ABSORPTION APPARATUS FOR EVALUATION OF INHIBITED TRANSFORMER OILS

(10–14-mesh size) in order to remove any carbon dioxide or water vapour that may be formed during the course of the oxidation reactions, (*c*) a manometer containing dibutyl phthalate, and (*d*) a manually-operated gas burette, water-jacketed in a similar manner to the absorption tube in order

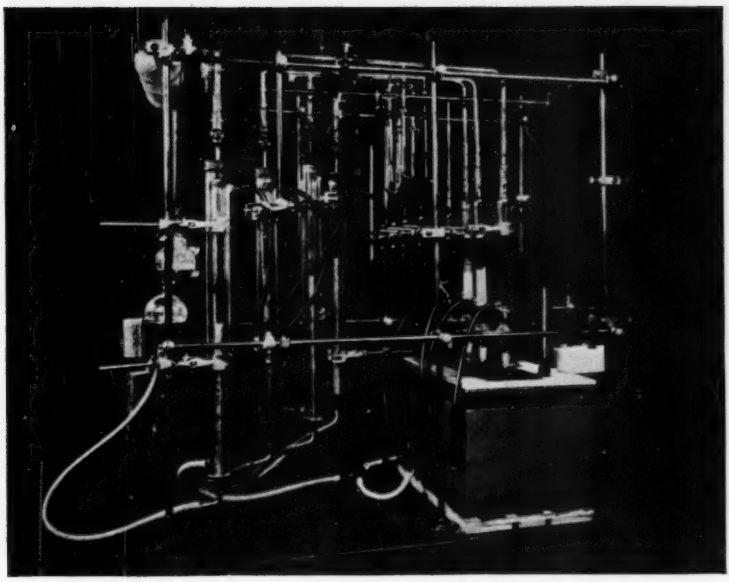

FIG. 2*b*

OXYGEN-ABSORPTION APPARATUS FOR THE EVALUATION OF THE OXIDATION STABILITY OF INHIBITED TRANSFORMER OILS

[*To face p.* 28.

to minimize the effects of room-temperature variations. The various component parts of the apparatus are fitted with standard cone-and-socket glass joints for ease in stripping, cleaning, and assembly.

Experimental Procedure

The required blend of oil, catalyst, and inhibitor is prepared and a 5-g (±0·02 g) sample is introduced into a 1000-ml flat-bottomed conical flask. The flask and contents are then immersed in a thermostatically-controlled oil-bath, the temperature of which is maintained constant at 120 ± 0·5° C; the buoyancy effect ensures a firm joint with the freshly charged absorber tubes. Pure dry oxygen from a cylinder connected to the inlet near tap *T* is then flushed through the apparatus for approximately 3 minutes, during which time the mercury (or dibutyl phthalate) reservoir is slowly lowered in order to draw oxygen into the gas burette. The flask is also flushed out by this procedure, since the oxygen pressure counteracts the buoyancy effect, and the excess oxygen escapes through the neck of the flask. At the end of this time the flask and its contents have attained constant temperature. The oxygen supply is now cut off and the time noted, this time being taken, for the purpose of the test, as " zero-time." The course of the reaction is followed by adjusting the pressure to *ca* 760 mm whenever the manometer registers a pressure difference of 10 to 20 mm dibutyl phthalate. Oxygen-volume readings, determined at approximately every 5 ml oxygen absorption (but more frequently during the induction period, since it is required to establish the duration of this more accurately) from the gas burette, are plotted against time. All experiments are normally taken to the point where 100 ml oxygen per 100 g oil have been absorbed, when the flask is removed, stoppered, cleansed externally, and allowed to cool. The sample is then examined for developed sludge and acidity in the usual manner (I.P. 56/46 and I.P. 1/46).

It will be appreciated that this procedure, designed primarily for the rapid evaluation of inhibited oils, tends to produce results which do not discriminate among uninhibited oils, which generally have 1000 ml/100 g oxygen-absorption times in the region of 0·75 to 5·0 hours and usually about 2 hours. On the other hand, the characteristic feature of an oxidation-inhibited transformer oil is that the oil, under the above test conditions, does not start to deteriorate immediately but only after a relatively long period of time. This period, during which little or no oxygen is absorbed, is termed the " induction period." It is only after the end of this period, which corresponds to the complete depletion of the inhibitor, that formation of acid and sludge takes place to a marked extent. It is clear that an assessment of the oxidation stability of inhibited transformer oils should include the induction period as a quantity of prime importance. The induction period also affords a measure of the susceptibility of an oil to a particular inhibitor, and is of use not only in comparing different oils containing the same inhibitor but also in comparing the effects of different inhibitors in the same oil.

Moreover, it is common experience that the rates of acidity development of oils in service begin to increase appreciably only after transformers have been on load for some time. It is hoped to establish a relationship between the induction period and the period of negligible deterioration in service.

Results

With the exception of oil A, the transformer oils, from which the oil/inhibitor blends were prepared, all meet the requirements of B.S. 148 : 1933, class B.30 or the proposed revision; oil A is the saturates fraction of a technical white oil and contains a negligible amount (<0·02 per cent weight) of aromatics.[6]

A comprehensive study has been made of: (i) the susceptibilities of various transformer oils to a particular inhibitor, (ii) the response of an oil to varying inhibitor amounts, and (iii) the relative efficiencies of different inhibitors (*e.g.*, amino- and phenolic-type compounds). In all experiments the repeatability of the induction period is of the order of ± 5 per cent of the mean result; the results quoted are, in the main, the average of either duplicate or triplicate determinations, single tests having been carried out in only a small number of cases. Whenever possible, the experiments have been continued to an oxygen absorption of 1000 ml/100 g oil; the times taken for the oils to absorb 50, 650, and 1000 ml O_2/100 g oil are designated by t_{50},* t_{650},† and t_{1000} respectively.

Inhibitor Susceptibility

The oxidation characteristics of a number of oils of differing degrees of refinement but containing the same concentration of a phenolic-type oxidation inhibitor (additive 1) are summarized in Table II; graphical illustrations of the type of oxygen absorption/time curves obtained for a few of these inhibited oils are shown in Fig. 3.

The overall increase in oxidation stability conferred by the addition of a relatively small amount (0·3 per cent weight) of an inhibitor is evident when the times taken for the inhibited oils to absorb 1000 ml O_2/100 g oil (8 to 25 hours) are compared with those for the uninhibited oils (2 to 4 hours). The test shows oils to have widely differing inhibitor susceptibilities, the induction periods varying from 2·5 hours (oil J) to 19·0 hours (oil A). In each case the end of the induction period is marked by a rapid increase in the rate of oxygen absorption, the subsequent oxidation rate approximating to that found when no inhibitor was present. The uninhibited oils have virtually no induction periods.

It will be noted that the induction period, and therefore the inhibitor susceptibility, increases with increasing degree of refinement, oil A, the saturates fraction from a technical white oil, having an induction period of 19·0 hours in contrast to values ranging from 12·7 to 2·5 hours for a group of transformer oils of decreasing degree of refinement. A similar relationship has been observed by Von Fuchs and Diamond [7] in their study of the oxidation characteristics of lubricating oils.

As the inhibitor susceptibility of an oil is increased, however (*e.g.*, by various refining processes such as solvent extraction, acid treatment), it

* This time has been found, for many oils, to correspond approximately to the duration of the induction period, and is of value if this is not sharply defined by the experimental observations.

† This time corresponds approximately to a level of oxidation equivalent to a developed acidity of about 1 mg KOH/g under these test conditions. The significance of this particular acidity value is that, in service, oils are then sometimes regarded as unfit for further use and may be reclaimed or discarded.

does not necessarily follow that the oxidation stability of the uninhibited oil is also increased. In fact, beyond a certain optimum point the reverse

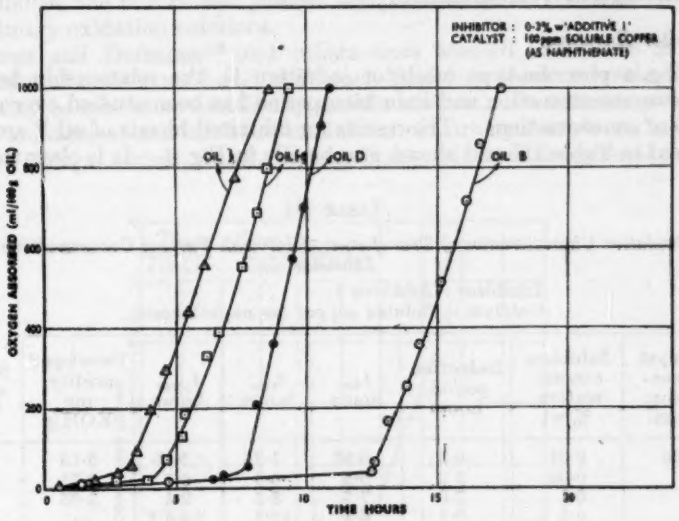

FIG. 3

OXIDATION CHARACTERISTICS OF INHIBITED TRANSFORMER OILS

TABLE II

Oxidation Characteristics of Inhibited Transformer Oils of Various Types

Inhibitor : 0·3 per cent weight additive 1.
Catalyst : Soluble copper (as naphthenate) 100 p.p.m.

Oil	Induction period, hours	t_{150}, hours	t_{650}, hours	t_{1000}, hours	Developed acidity, mg KOH/g	Sludge value, % wt	B.S.148 Oxidation Test	
							Acidity, mg KOH/g	Sludge, % wt
A	19·0	19·6	23·4	24·2 *	—	—	3·05	0·03
B	12·7	9·9	16·4	17·7	3·6	0·19	3·95	0·51
C	8·5	—	—	—	—	—	1·20	0·76
D	7·8	7·7	9·7	10·9	2·95	0·29	4·05	0·56
E	8·7	9·05	11·8	13·1	2·6	0·38	1·75	0·76
F	10·3	10·8	13·8	14·7 *	—	—	2·30	0·85
G	7·2	4·8	12·7	16·3	2·3	0·51	1·80	1·04
H	4·0	4·3	7·9	9·3	1·8	0·33	1·85	1·09
I	6·5	7·0	11·5	14·8	2·75	0·65	1·35	0·92
J	2·5	2·6	6·3	8·6	1·35	—	1·30	1·01

* Extrapolated value.

Oils A–J are in decreasing order of refinement in terms of acid and oleum treatment, oil A being most highly refined.

tends to be true, oxidation stability (as measured, for example, by sludge and acidity determinations after the B.S.I. oxidation test) decreasing with increasing degree of refinement.

The induction period is not, therefore, the sole criterion of quality of an inhibited transformer oil, the stability of the uninhibited oil itself being also an important consideration.

Inhibitor Response

Using a phenolic-type inhibitor (additive 1), the relationship between inhibitor concentration and induction period has been studied over a wide range of concentrations. The results for inhibited blends of oil F are summarized in Table III and shown graphically in Fig. 4. It is clear that the

TABLE III

Oxidation Characteristics of Transformer Oil F with Various Concentrations of Inhibitor

Inhibitor : Additive 1.
Catalyst : Soluble copper (as naphthenate).

Catalyst concentration, p.p.m.	Inhibitor concentration, % wt	Induction period, hours	t_{50}, hours	t_{650}, hours	t_{1000}, hours	Developed acidity, mg KOH/g	Sludge value, % wt
500	0·01	0·8	0·95	1·75	2·15	3·15	0·33
	0·05	5·2	5·4	6·3	6·7	2·75	0·28
	0·1	7·0	7·3	8·5	9·4	3·05	0·41
	0·2	9·2	9·4	12·2	14·6 *	—	—
	0·3	11·7	12·0	14·2	15·6	3·35	0·48
	0·4	10·0	10·1	11·1	—	—	—
	0·5	*ca* 16	*ca* 16	18·0	—	—	—
	0·75	24·5	*ca* 7	26·4	27·1	3·50	0·65
	1·0	31·0	2·8	34·8	—	—	—
100	0·01	0·7	0·75	1·8	2·35	2·15	0·11
	0·05	4·2	4·4	5·7	6·4	2·40	0·12
	0·1	7·1	7·1	8·6	9·4	2·65	0·13
	0·2	8·9	9·1	11·1	11·8	3·35	0·24
	0·3	10·3	10·8	13·8	14·7 *	—	—
	0·4	14·9	15·9	20·9	—	—	—
	0·5	24·0	18·5	30·7	34·4	—	—
	0·75	63·7	45·1	72·5	76·5 *	—	—

* Extrapolated value.

relationship is complex and is dependent upon the concentration of catalyst. A tentative explanation which accounts for the form of these inhibitor response curves is as follows :—

One of the characteristic features in the oxidation of many liquid hydrocarbons is that the reaction proceeds by a chain mechanism involving, as chain carriers, either free radicals or energy-rich molecules, depending upon the type of hydrocarbon being oxidized as well as upon the conditions under which the oxidation is taking place. Investigations by many workers [8,9,10] have shown that the course of oxidation consists of the primary formation of a peroxide (by a chain mechanism in which hydrocarbon and oxygen are involved) followed by a decomposition of this peroxide to give either a ketone or an alcohol or both, depending upon the nature of the peroxide formed. There is strong evidence [9,10,11] that the more highly oxidized products (such as acids) which are formed in liquid-hydrocarbon oxidations

are derived by further oxidation of the ketone; recent work [12] has indicated that in the oxidation of transformer oils, these products can polymerize to form sludge, the rate of the process being, however, slow compared with the primary oxidation reactions.

Moureu and Dufraisse [13] and others have studied oxidations at low temperatures and have found that such reactions show a marked susceptibility to inhibitors and heavy-metal catalysts. In extensive studies on the uninhibited and inhibited oxidations of pure hydrocarbons, notably tetralin, George, Rideal, and Robertson [10] showed, from the general theory

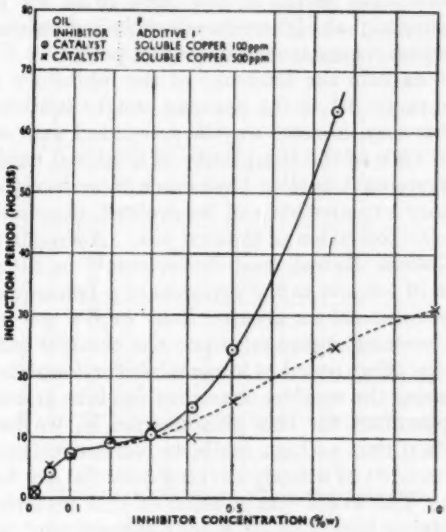

FIG. 4

RELATION BETWEEN INHIBITOR CONCENTRATION AND INDUCTION PERIOD

of chain reactions, that the relation between the inhibitor concentration and the induction period could be represented by the equation :—

$$[I] = at_i \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where $[I]$ = initial inhibitor concentration,

t_i = induction period,

and a = rate of chain initiation of the uninhibited oxidation,

assuming that : (i) the reaction is strongly inhibited, *i.e.*, the ratio of the uninhibited rate to the inhibited rate tends towards infinity, (ii) one molecule of inhibitor is removed for each chain stopped, and (iii) the inhibitor reacts with the chain carrier involved in the normal chain termination reaction.

Equation (1) predicts that a plot of inhibitor concentration *versus* induction period should be a straight line, the slope of which is equal to the

rate of chain initiation of the uninhibited oxidation. This condition is obviously fulfilled by inhibited blends of oil F in the region of zero to 0·1 per cent weight inhibitor (Fig. 4); the results indicate that the rate of chain initiation of the uninhibited oxidation is of the order of 2×10^{-7} moles/litre/second.

However, at inhibitor concentrations greater than 0·1 per cent weight, the induction period becomes relatively insensitive to changes in this experimental variable up to *ca* 0·4 per cent weight inhibitor when the induction period again increases with higher percentages. Increasing the soluble copper catalyst concentration from 100 to 500 p.p.m. has little effect upon the induction period at low (zero to *ca* 0·4 per cent weight) inhibitor concentrations; at higher concentrations, however, increasing the catalyst concentration decreases the induction period.

It is difficult to explain the tendency of the inhibitory effect to become constant over the range 0·1 to 0·4 per cent weight inhibitor. A tentative suggestion is that it may, in some way be associated with catalyst/inhibitor interaction, but in view of the complexity of inhibited oxidations in heavy-metal-catalysed systems it is clear that much more work will be necessary before a satisfactory explanation can be evolved, especially in the case of studies involving the oxidation of mineral oils. A similar phenomenon has been noted by George, Rideal, and Robertson [14] in their studies on the thermal oxidation of tetralin in the presence of *p*-benzoquinone.

At inhibitor concentrations greater than *ca* 0·4 per cent weight, the induction period becomes dependent upon the catalyst concentration (Fig. 4), in contrast to the effect noted at lower inhibitor contents. In particular, the effect of increasing the catalyst concentration is to decrease the induction period. The explanation for this phenomenon is, we believe, connected with the observation that at high inhibitor concentrations, small amounts ($<0{\cdot}05$ per cent weight) of a finely divided material are formed during the induction period. The exact composition of this material is not known; experiments involving blends of oil F with 0·6 per cent weight additive 1 have been terminated at various points during the induction period and the insoluble matter removed by rapid filtration : the results indicate that the insoluble material contained a relatively large amount of copper. Analyses of the oils at various times from the start of the test and after rapid filtration show that the oil-soluble copper concentration (initially 100 p.p.m.) decreases rapidly until, after 10 hours on test, only 10 p.p.m. copper is present in solution, the " inactive " copper being presumably located in the insoluble portion (Fig. 5 summarizes the results obtained). Owing to the very small amounts of insoluble matter formed it was not possible to carry out exact analyses for copper on this material; previous observations that sludges (formed during the oxidative deterioration of oils in the presence of oil-soluble copper) contain relatively large amounts of copper would, however, support the view that a similar process is operative under the present conditions.

The relatively rapid increase in the induction period at a catalyst concentration of 100 p.p.m. and inhibitor concentrations greater than about 0·4 per cent weight (Fig. 4) can thus be explained as resulting from oil-soluble-catalyst depletion which reduces the amount of soluble copper to such an extent that the conditions tend to approach those operative in

uncatalysed inhibited systems which show much longer induction periods. On increasing the catalyst concentration to 500 p.p.m. it would appear reasonable to assume that, at any fixed time during the induction period and at a particular inhibitor concentration, the oil-soluble copper concentration will be greater than under similar conditions at lower catalyst concentrations. The induction period at a copper concentration of 500 p.p.m. (which has suffered some depletion) will thus approach more closely that which would have been obtained if no catalyst depletion occurred, and hence a decrease in induction period is observed compared with that at a catalyst concentration of 100 p.p.m. (which has suffered a larger percentage depletion).

It must be emphasized that the above theory is not regarded as being complete and will undoubtedly require modification in the light of further

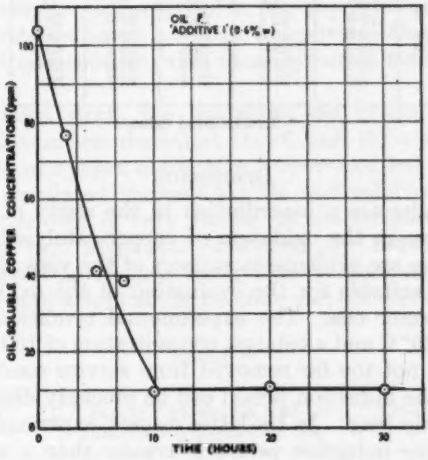

FIG. 5

RELATIONSHIP BETWEEN OIL-SOLUBLE COPPER CONCENTRATION AND TIME DURING THE INDUCTION PERIOD

work; the fundamental basis of the theory, *i.e.*, catalyst depletion, is however, fully confirmed by experiment. The actual mechanism of the process will certainly be complex, involving the interaction of all the reactant variables, viz., hydrocarbons, inhibitor, catalyst, and oxygen.

Inhibitor Efficiency

The results obtained using oxidation inhibitors of differing types are shown in Table IV; additive 2 is a phenolic compound (of different structure from additive 1), and additives 3 and 4 are both amino-type compounds. As would be expected, the test shows different inhibitors to have differing effects (as measured by the induction periods) in the same oil, the amino-type compounds examined in the present work being intermediate, in inhibitor efficiency, between phenolic additives 1 and 2 in oil F. The results for additive 2 confirm the previous conclusion that the susceptibility

of an oil to a particular oxidation inhibitor is governed very largely by the degree of refinement of the oil.

TABLE IV

Oxidation Characteristics of Transformer Oils Containing Various Additives

Temperature: 120° C.
Catalyst: Soluble copper (as naphthenate) 100 p.p.m.

Oil	Additive			Induction period, hours	t_{10}, hours	t_{300}, hours	t_{1000}, hours	Developed acidity, mg KOH/g	Sludge value (pet. spirit-insolubles), % wt
	Reference	Type	Concentration, % wt						
B	1	phenolic	0·3	12·7	9·9	16·4	17·7	3·60	0·19
B	2	phenolic	{0·1	24·1	24·5	26·8	27·7	2·50	0·15
			{0·3	47·0	48·3	51·8	52·5	2·60	0·13
I	1	phenolic	0·3	6·5	7·0	11·5	14·8	2·75	0·65
I	2	phenolic	{0·1	5·6	5·8	7·5	—	—	—
			{0·3	22·4	23·2	26·0	29·9	3·05	0·62
F	1	phenolic	0·3	10·3	10·8	13·8	14·7 *	—	—
F	2	phenolic	0·3	38·7	39·3	43·5	45·5	3·65	0·20
F	3	amino	0·3	18·0	18·3	20·9	22·0	2·45	0·60
F	4	amino	0·3	21·1	21·4	22·7	23·4	2·45	0·40

* Extrapolated value.

DISCUSSION

The above results are a contribution to the study of the fundamental processes operative in the oxidation of copper-catalysed inhibited hydrocarbon oils. They are evidence in support of the view that a test method of this nature is suitable for the evaluation of the oxidation stability of inhibited transformer oils. The experimental conditions chosen, viz., a temperature of 120° C and a catalyst concentration of 100 p.p.m. copper (as naphthenate) are not too far removed from service conditions in a transformer and also the induction period can be precisely determined in a time which is not unduly long. In the latter respect, experience has shown that if the length of the induction period is greater than a working day (*ca* 8 hours) then the oil/inhibitor system is not disturbed if the sample is removed from the apparatus and stored until the following day, when the test can be continued. Of course, this procedure is not possible if the inhibitor has been depleted and rapid oxidation is taking place.

Another desirable feature is that the apparatus is relatively simple and is easy to re-assemble after cleaning; no specialized technique is necessary during operation, and four units can, with ease, be utilized with one oil-bath, the temperature of which is thermostatically controlled.

Work recently reported by Krieger [15] has indicated that metallic copper which is free from cuprous oxide (Cu_2O) has no catalytic effect upon the rate of oxidation of transformer oil. This observation led to the view that cuprous oxide (which is always present in metallic copper unless extreme precautions are taken to ensure its absence) is the effective catalytic agent, and not the copper as was previously supposed. Using a solid copper catalyst, the cuprous oxide present will undoubtedly be attacked by the acids formed during the oxidation of an oil, with the consequent formation of oil-soluble organic copper salts. The catalytic effect of copper dissolved in an oil is well established, and thus Krieger concluded that " since it is

impossible to use Cu_2O directly owing to the variation of the surface in contact with the liquid, it would appear that the addition of an organic salt (stearate, palmitate, etc.) would be the best solution in order to ensure the presence of a catalyst during the test."

An objection to the use of a soluble catalyst has been made by Wood-Mallock,[16] who, on the basis that oils refined by various methods can differ with respect to their ability to attack metals, is of the opinion that " if we standardize on soluble salts, we may ignore that many oils will, in fact, be more actively catalysed in their oxidation than when used in transformers where bare iron and bare copper are present."

In the formulation of any internationally acceptable oxidation test for the evaluation of either uninhibited or inhibited transformer oils it is clear that considerable importance must be attached to the problem of deciding in what physical state the catalyst is to be employed. In this connexion and with reference to the test proposed in this paper, work has been carried out in these laboratories in an attempt to correlate the results obtained using a soluble copper catalyst with those obtained using polished, solid copper foil.*

For this correlation work, the oxidation test procedures used were: (*a*) the static oxidation test described above, and (*b*) a test similar to (*a*) in so far as the rate of oxygen absorption is measured but under conditions where oxygen is circulated through the oil and solid copper is used as catalyst. The latter test is very similar to the automatically-recording oxygen-absorption test apparatus described by Larsen, Thorpe, and Armfield,[9] an interesting feature being that volatile oxidation products (such as low-molecular-weight acids, ketones, etc) are condensed out in cold-

TABLE V

Experimental variable	" Static " oxidation test for inhibited transformer oils	" Circulatory " oxidation test
Temperature	120° C	120° C
Sample weight	5 g	100 g
Catalyst	Soluble copper (as naphthenate)	Solid copper foil
Catalyst concentration	100 p.p.m.	220 cm^2 surface area
Atmosphere	Oxygen	Oxygen
Pressure	1 atm	1 atm

traps inserted in a closed system through which oxygen is continually circulating. The rate of flow of oxygen through the oil is such that excess oxygen is present, and thus the oxygen-absorption rate represents the absolute chemical rate of oxidation. Table V summarizes the essential differences between the two oxidation tests.

At an inhibitor concentration of 0·3 per cent weight (additive 1) there is a good correlation between the induction periods, obtained by the two oxidation tests, for various oil/inhibitor blends (Fig. 6). As would be expected, the induction periods obtained using the " circulatory " oxidation

* As used in the B.S. 148 : 1933 oxidation test, and polished in the same way.

test are longer than those obtained under " static " conditions by virtue of the fact that solid copper is a less-active catalyst than soluble copper. From these results it would thus appear that no serious disadvantages are attached to the use of a soluble copper catalyst as opposed to the same metal catalyst in the solid state. The latter, on the other hand, leads to increased test durations, and needs careful preparation in order to ensure a fixed surface area which is, at the same time, regular and reproducible.

In order to ensure that diffusion is not operative as a rate-limiting factor in these oxidations, the oil-sample weight is fixed at 5 g. Experiments involving the oxidation of thin films of oil of relatively large surface area show that the rate of deterioration (as measured by the rate of oxygen absorption) is not, in this instance, predominantly controlled by a diffusion process over a range of oil-film depths. However, as the amount of oil is increased beyond a certain limit (*ca* 10 g oil) diffusion becomes operative as a rate-determining factor, this being evidenced by a slower oxidation rate.

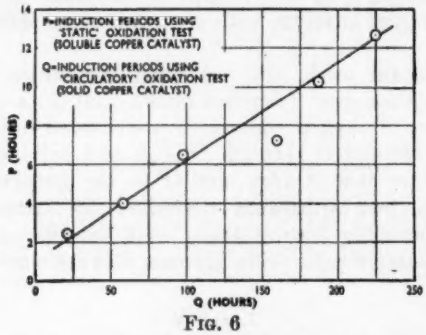

FIG. 6

RELATION BETWEEN " STATIC " AND " CIRCULATORY " OXIDATION TESTS FOR INHIBITED OILS

One important advantage of the " static " oxidation test is that it permits a rapid estimation to be made of the inhibitor content of inhibited transformer oils in service. Samples are taken periodically from the transformer and measurements are made of their induction periods under the experimental conditions described above. Assuming that, for a given oil and additive, the induction period is a measure of the inhibitor content, the rate of depletion of inhibitor is thus obtained.

The user will have considerable interest in measurements of this nature, where attempts are made to estimate the probable remaining life of an inhibited transformer oil in service prior to the end of the induction period conferred by the additive.

It must be emphasized that the experimental conditions chosen, viz., temperature, 120° C, catalyst concentration, 100 p.p.m. soluble copper; apply to the evaluation of the oxidation stability of inhibited transformer oils and not necessarily to the evaluation of other types of inhibited oils. In the latter case, as for example with turbine oils, recent work in these laboratories has shown that the experimental conditions, especially in respect of catalyst concentration, must be modified in order that a well-defined and reproducible induction period may be obtained.

ACKNOWLEDGMENTS

The authors wish to thank A. W. Jeffrey and G. C. Price for assistance in the experimental work, J. R. Bates and Miss M. K. Jones of the Analytical Section for the various analyses involved, and A. J. Ham for valuable discussions. Thanks are also due to " Shell " Refining and Marketing Co. Ltd. for permission to publish this paper.

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DITHIONETHIOPHANES

By Walter Friedmann *

Summary

In the course of a re-examination of the reaction taking place, under certain conditions, between 2 : 2 : 4-trimethylpentane and sulphur, two isomeric compounds $C_8H_{12}S_2$ have been isolated. One of the isomers, m.p. 86° C, may be considered as belonging to the dithione–thiophane series; the other isomer contains a sulphydril group, as ascertained by alkaline sodium nitroprusside and by infra-red absorption spectrum.

Previous work pertaining to the reaction of the sulphur with hydrocarbons [1] indicates that starting with 2 : 2 : 4-trimethylpentane, a reaction ensues with the formation of a mixture of thiophanes $C_8H_{16}S$. One com-

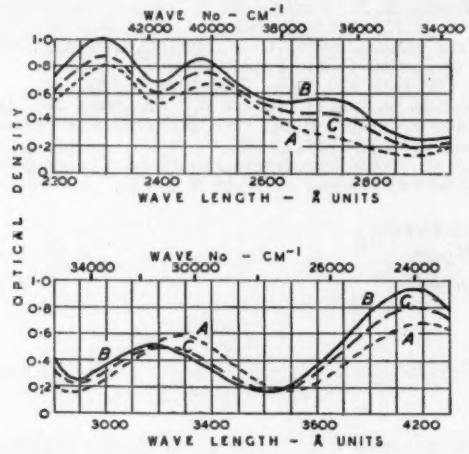


Fig. 1

Compound—$C_8H_{12}S_2$.
Source and purity—from 2 : 2 : 4-trimethylpentane.
State—liquid in *iso*octane.
Temperature—25° C.
Cell length—1·0 cm.
Concentration—A 0·0189 g/l.
B 0·0213 „
C 0·213 „
Laboratory—Universal Oil Products Co., Riverside, Ill., March 15, 1948.

ponent of this mixture contained in the 158°–161° C range was identified as a thiophane by the formation of a sulphone and the methyliodide $C_8H_{16}S,CH_3I$ and by its transformation into a thiophane $C_8H_{12}S$ on dehydrogenation of this fraction with the aid of selenium.

The same fraction (158° to 161° C), when heated for some time with sulphur under reflux, produced (besides the thiophene, identified by the isatin colour reaction) a residue solidifying at room temperature. After dissolving this residue in benzene and adding absolute alcohol to the

* Petróleos Mexicanos, México, D.F.

solution, and standing overnight, golden yellow needles separated out. After two recrystallizations, these showed a constant melting point of 86° C (compound A on Fig. 1).

The original solid reaction product from 2 : 2 : 4-trimethylpentane, plus sulphur,[1] which separated from the solution in a freezing mixture as a crystalline cake on recrystallization from glacial acetic acid gave crystals of m.p. 81°/82°, marked as C on Fig. 1.

This solid portion represents a mixture of two or perhaps three components, from which, after many recrystallizations, the less-soluble compound A (m.p. 86° C), separated first. The more readily soluble products remaining in the mother solutions were not investigated at that time, but have since been studied. A second compound has been obtained from the afore-mentioned mother solutions in the form of yellow leaflets, m.p. 74°/75° C, marked as B on Fig. 1.

Referring to Fig. 1 :—

A are the yellow needles, m.p. 86° C;

B is the yellow compound, m.p. 74°/75° C, segregated from the mother solution;

C is the reaction product recrystallized from glacial acetic acid.

Microanalysis *

	A found	*B* found	*C* found
S	47·58	47·51	47·67
H	5·67	5·49	—
C	47·01	47·19	—
Mol weights * . . .	199–206	200–208	192–198

Calculated for $C_8H_{12}S_3$, 204.
Calculated for S 47·05, H 5·88, C 47·05.
* Reported by Dr. Carl Tiedke, New York.

(The empirical formula first given [1] was tentative, based only on the sulphur analysis with 45·5 per cent S; however, this cannot now be supported.)

From A and B only a few derivatives could be prepared because the available quantities considered as pure were very small.

Mercuric chloride complex from A : $C_8H_{12}S_3,1HgCl_2$, m.p. 205°/207° C.
Mercuric chloride complex from B : $C_8H_{12}S_3,2HgCl_2$, m.p. 188° C.

Both compounds are microcrystalline yellow needles which decompose when heated above their melting points.

From A the ethyliodide was prepared, $C_8H_{12}S_3,C_2H_5I$, m.p. 146° C.
From B the ethyliodide was prepared, $C_8H_{12}S_3,C_2H_5I$, 129°/130° C.

The oxidation of A and B with "Perhydrol" seems to be of interest because, simultaneously with the formation of the liquid sulphones, the quantity of sulphuric acid formed in the course of the oxidation of A is equivalent to the oxidation of two sulphur atoms to sulphuric acid, whereas the quantity of H_2SO_4 formed in the oxidation of B is much smaller.

Another observation to which special attention must be directed is the

red-purple colour reaction taking place only between the B-product, alkaline sodium nitroprusside, and 2 mols of 2*N*-NaOH, indicating the presence of mercaptan groups. The A-product treated with the same reagent does not exhibit the purple colour reaction, thus indicating the absence of mercaptan groups.

As Fig. 1 shows, the three compounds A, B, and C exhibit quite distinct crystallographic structures, but they all have the same C, H, and S content and the same molecular weight (204), corresponding to the formula $C_8H_{12}S_3$. The compounds have distinct melting points, and derivatives from A and B also exhibit differences too. Therefore, A and B may be considered as isomers.

By courtesy of Dr G. Egloff the ultra-violet and infra-red examinations of these compounds were carried out in the Research and Development Laboratories of the U.O.P. Co., by Dr A. S. Gallaway and Dr M. J. Murray, who interpreted the curves of the absorption spectra (Fig. 2) as follows :—

" *A comparison of the infra-red absorption curve shows A, B, and C are mixtures of at least two components. Compound B is definitely rich in one of the components, C is slightly richer than A with regard to the main component B.* B appears to have some S–H-groups. The presence of this group in A or C is not established. *Beyond the above, we can say only that the compounds are rather highly branched.*"

" *The ultra-violet absorption spectra of A and B show that they are made up of molecules containing* different, *but related chromophoric groups. C appears to be a mixture of A and B.*"

In any event, the absorption spectra seem to indicate the existence of isomeric $C_8H_{12}S_3$ compounds.

Regarding the structure of these compounds, the investigations of M. L. Selker and A. P. Kemp [2] on the rubber-vulcanization problem and the sulphur linkage in vulcanized rubber should be mentioned. Investigating the reaction of 2-*methyl*-2-*butene* with sulphur in relation to reaction time, temperature, and concentration, they obtained as reaction products liquids of the polysulphide type R–S*x*–R and two solids; $C_5H_6S_3$ and a higher homologue. In disagreement with Böttcher and Lüttringhaus,[3] who have synthesized compounds of the type $C_5H_6S_3$ v.g. from *iso*prene +S, considering same as " *trithiones.*" Selker and Kemp propose for $C_5H_6S_3$ the structure of a cyclic anhydride in the sulphur system, with *thionethiol tautomerism*, that is 2 : 5-dithione-3-methyl-tetrahydrothiophene.

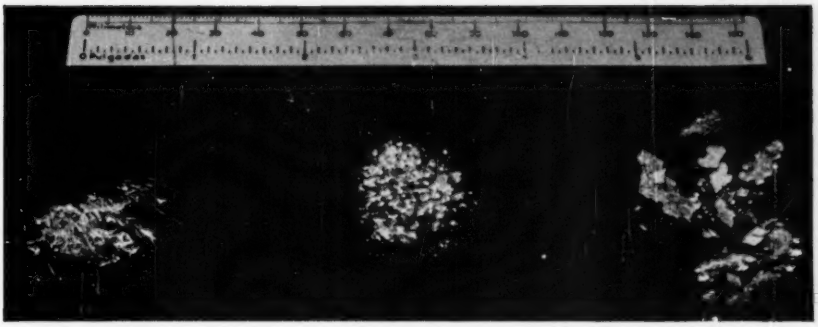
The authors' deductions for the possible structures of $C_5H_6S_3$ may be applied to the structure of the sulphur compound $C_8H_{12}S_3$. Their principal arguments are :—

(1) the methyl or ethyl iodide reaction shows the presence of one single sulphide sulphur (not α to a double bond);

(2) the oxidative splitting off of two sulphur atoms by hydrogen peroxide indicates the presence of two C–S groups.

Both arguments are valid also for the present case, and a third, the strongest, has to be added :—

(3) the A compound, m.p. 86° C, is formed by interaction of the thiophane $C_8H_{16}S$ and sulphur = $C_8H_{12}S_3$, assuming that the sulphur enters into the thiophane system by substitution.

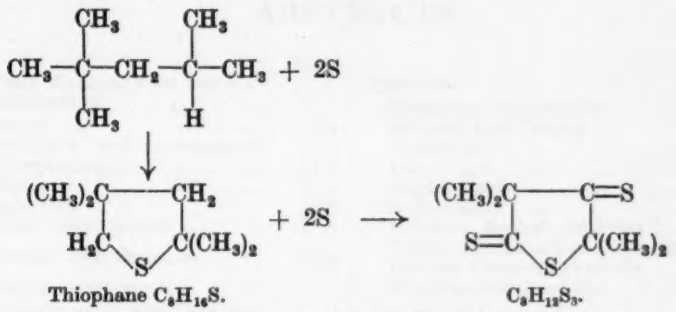


A B C

FIG. 2

[*To face p. 42.*

Accepting the above given arguments, the formation of the A-compound $C_8H_{12}S_3$ may occur in the following manner :—



Thiophane $C_8H_{16}S$. $C_8H_{12}S_3$.

3 : 5-Dithione-2 : 2 : 4 : 4-tetramethyl tetrahydrothiophene.

On the other hand, taking into consideration the various possibilities for the isomerization of 2 : 2 : 4-trimethyl pentane resulting from its lengthy heating at 285° C with sulphur it seems preferable to abstain from guessing how the B-product, with the mercaptan groups, may originate.

However, only thiophanes and thiophane derivatives—the dithione thiophanes—are the products resulting from the reaction of sulphur upon *iso*octane (under the conditions stated above).

In 1916, the author showed [4] that, under the same conditions, the thiophane $C_8H_{12}S$ and the thiophthene $C_8H_8S_2$ are obtained from *n*-octane plus sulphur. In 1929, treating in the same way *n*-heptane with sulphur, Baker and Reid [5] proved the presence of a thiophene in the reaction product.

The different behaviour of the normal and of the *iso*paraffins treated under the same conditions may be rather surprising.[6] But taking into account the much lower activation energy of the *iso*paraffins compared with that of the *n*-paraffins the phenomena is easily understood. When the *iso*paraffins are superheated up to the same temperature as the *n*-paraffins the disintegration of the former must be stronger than that of the latter. In fact, starting from *iso*octane [1] the presence of dimethylsulphide (identified as sulphone) has been proved in the reaction product; further, the formation of mixtures of methylethyl sulphide plus diethyl sulphide can be assumed. That is, the *iso*octane, in part, splits during the reaction into methyl and ethyl fragments, and these radicals, in a side reaction, associate under the influence of temperature and pressure with the sulphur-forming sulphides. In this way these quantities of sulphur, and likewise the sulphur entering in the thiophane ring, producing the dithione thiophanes, are inactivated and are not available for dehydrogenating the thiophanes to thiophenes.

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Oilfield Exploration and Exploitation

Geology

1. Jacksonian stage. G. E. Murray and L. J. Wilbert. *Bull. Amer. Ass. Petrol. Geol.*, **34** (10), 1990–7.—The term Jacksonian is introduced as a time and time-rock unit replacing Jackson formation and Jackson group as a major division of the Eocene sediments of the Gulf and Atlantic Coastal Plain. The use of Jacksonian as an age and stage term reflects current trends towards definition of standardized chronological divisions in other regions, recognizes the natural basis for unit treatment of this sedimentary entity, and permits more accurate description of the upper Eocene portion of the stratigraphic column.

Suggestions for similar establishment of other natural divisions of Gulf Coast Tertiary sediments are made. E. N. T.

2. International. Anon. *Oil Gas J.*, 18.5.50, **49** (2), 109–10.—1 Los Mangos in Venezuela has given 600 b.d. of 34·4° oil. It is 6 miles from the nearest oil production at Santa Ana AG-1. Oficina OG-286 has found oil 2·2 km from previous production, and East Leona LXG-101 has given 250 b.d. of 22·5° oil from 7440 ft, and is 3·8 km from previous production. These two wells seem to mark new pools.

2 km west of Tucupido TUX-2 is rated as a discovery, while the Belen pool was opened by a well which gave 162 b.d.

In France, near Pau, an Upper Cretaceous well at 2330 ft has produced about 110 b.d. A second well is reported to have flowed about 180 b.d. from 2025 ft. In the Soultz-sous-Forets field nine producers have been completed out of eleven wells, and three give about 100 b.d. G. D. H.

3. International. Anon. *Oil Gas J.*, 8.6.50, **49** (5), 41.—8 Lingen-Dalum in the Emsland area of Germany has flowed 380 b.d. on a 10-mm choke. It is ½-mile east of the Dalum field.

No. 2 Tetuan, northwest of Artega in the Upper Magdalena Valley, was drilled to 2767 ft, and is reported to have given 1000 b.d.

A well is being drilled on a sand spit 13 miles east of Barranquilla. G. D. H.

4. Wildcat drilling in 1949. F. H. Lahee. *Oil Gas J.*, 11.5.50, **49** (1), 70.—See Abs. No. 1792, 1950. G. D. H.

5. Arkansas wildcat found. Anon. *Petrol. Engr*, Sept. 1950, **22** (10), B-84.—1 E. V. White, Union County, South Arkansas, initially produced 15 b.d. of 24° oil and 961,000 cu. ft. gas from the Meakin Sand at 2476–2479 ft. G.O.R. was 64,000 : 1. C. A. F.

6. Cairo Field, Union County, Arkansas. L. A. Goebel. *Bull. Amer. Ass. Petrol. Geol.*, **34** (10), 1954–80.—During 1948 and 1949, four oilfields with exceptional oil–water contacts and abnormally low bottom-hole pressures were discovered in South Arkansas. The producing reservoir in all of the fields is the Reynolds oolite member of the Smackover formation.

The structure of each field does not appear to be the controlling influence on the reservoir, inasmuch as wells located structurally high produce water, whereas flank wells produce oil. It has been suggested that the various oil–water contacts in each field reflect the presence of individual porous and permeable zones within the reservoir, but it can be shown that the oil–water contacts in two of the fields display a definite pattern, and the writer believes that this pattern is determined by factors outside the confines of the field.

The Haynesville formation, a new formation name proposed by the Shreveport Geological Society for the thick red sand, shale, and anhydrite beds which overlie the Smackover formation and which some geologists consider as the lower Cotton Valley formation, is also discussed. In this proposed classification the Buckner formation is treated as the basal member of the Haynesville formation. E. N. T.

7. San Ardo—a stratigraphic analysis of a California oilfield. T. A. Baldwin. *Bull. Amer. Ass. Petrol. Geol.*, **34** (10), 1981–9.—The San Ardo oilfield in the Salinas Valley of coastal California is a stratigraphic trap occurring at an updip shale edge of the upper Miocene Lombardi sand. The water-table of the San Ardo field was warped synclinally during the early Pleistocene, dating this as a Pliocene accumulation. The stratigraphic features of the area are discussed, and it is shown that the shoreline edge of sands in the Salinas Valley is not suitable for accumulation.

It is suggested that Pleistocene structures should be discounted during future exploration in the Salinas Valley. E. N. T.

8. Cuyama Valley still commands interest. Anon. *Oil Gas J.*, 8.6.50. **49** (5), 109.—In the Cuyama Valley (California), Russell Ranch has 138 producers, and South Cuyama, 4 miles to the southeast, 120. The North Cuyama area was opened in April by a 450-brl well at 5635–6105 ft. It is 3 miles northwest of Russell Ranch. A 100-brl pumper has been completed at 1750–1920 ft in the Morales sand in an attempt to extend production ¼ mile to the southwest.

In the eastern and southern parts of the valley there have been no successes to date, but wildcatting continues. G. D. H.

9. McDonald anticline, California has new production. Anon. *Petrol. Engr*, Sept. 1950, **22** (10), B-90.—Layman 2, on the McDonald anticline, San Joaquin Valley, was completed for 240 b.d. of 29·8° oil and 25,000 cu. ft. gas/day from 80 ft of Buttonbed Sand, topped at 1977 ft. C. A. F.

10. New oil pool in California. Anon. *Petrol. Engr*, Sept. 1950, **22** (10), B-88.—Drummond Unit 2, six miles east of Hanford, Kings County, flowed 150 b.d. of 18·5° oil from a total depth of 5404 ft. C. A. F.

11. Gas production indicated at Colorado test well. Anon. *Petrol. Engr*, Apr. 1950, **22** (4), B-96.—A well west of Peetz, Colorado, on test had an indicated flow of 3,500,000 cu. ft. gas/day from the Muddy Sand from 5260–5270 ft. C. A. F.

12. Colorado gas well. Anon. *Petrol. Engr*, Sept. 1950, **22** (10), B-84.—A well drilled in the Feep Creek area, Carbon County, Colorado, flowed 10 M.c.f. gas/day from a Tertiary sand from 2462–2474 ft. Cloverly sands are to be tested. C. A. F.

13. Kansas well flows at rate of 11,000 bbl per day. Anon. *Petrol. Engr*, Apr. 1950, **22** (4), B-90.—3 Page Estate, Barber County, Kansas, is reported to have flowed 11,000 b.d. of 28° oil on test. Total depth is about 4400 ft. The well is in the recently opened Rhodes field. C. A. F.

14. Kansas gets 95th find. Anon. *Petrol. Engr*, Sept. 1950, **22** (10), B-88.—1 De Young, in Graham County, Kansas, made 3000 b.d. on drawdown test from the Arbuckle from 3826–3839 ft. The well is 1½ miles south of the Morel field. C. A. F.

15. East Village Mills field currently a Gulf Coast hot spot. O. S. Hervey and B. E. Booth. *Oil Gas J.*, 22.6.50, **49** (7), 200.—East Village Mills has produced over 300,000 brl from forty-eight oil wells. The discovery produced 255 b.d. from the Yegua at 7068–1066 ft, with a G.O.R. of 634. A Cockfield sand at 5955–5959 ft showed oil on test. The electric log showed that nearly every sand through the 1300-ft Yegua section appeared to have oil or gas. Four major sands are being developed.

The structure is an east–west fold on the downthrown southern side of an east–west fault. The throw is 100–185 ft. The oil is 40·5°–42·5° and the G.O.R. ranges 530–800. There was no original gas cap. A water drive is suspected. G. D. H.

16. Status report on offshore drilling in Louisiana. A. L. Vitter. *Oil Gas J.*, 22.6.50, **49** (7), 221.—The Creole field was opened in 1938. The Ship Shoal Block 32 field was discovered in 1947 and overlies and flanks a piercement salt dome. The five wells have sands at 1700–3200 ft. Salt was at 2563 ft in the discovery. No salt has yet been found in the main Pass Block 69 field which produces at 5800–8200 ft. The Gulf Isle Block 18 field is a piercement salt dome with salt at 8600 ft. Grand Isle Block 16 is similar, and Bay Marchand Block 2, opened in 1949, has salt at 2120 ft, and production at 3000–6000 ft. Other discoveries are South Tembalier Block 34, West Cameron Block 33, Breton Sound Block 32, West Cameron Block 45, Eugene Island Block 125, and South Pass Block 24. There are also eleven gas fields which are shut in. Twelve development wells and four wildcats are drilling.

A map shows the offshore development. G. D. H.

17. Lakeside field extended. Anon. *Petrol. Engr*, Sept. 1950, **22** (10), B-86.—1 Lacassine, an extension to the Lakeside field, Cameron Parish, South Louisiana, on completion flowed 22·47 b.d. of condensate and 1,120,000 cu. ft. gas from 9974–9990 ft. C. A. F.

18. Gulf and Hunt have new deep formation opened. Anon. *Petrol. Engr*, Sept. 1950, **22** (10), B-88.—2 Green, in Pointe Coupee Parish, Louisiana, on test produced 310 b.d. of 56·9° oil and 8,250,000 cu. ft. gas from 9066–9094 ft. Production had previously been found between 8100 and 8300 ft. C. A. F.

19. Progress report on Weeks Island. E. G. Christianson. *Oil Gas J.*, 22.6.50, **49** (7), 198.—Weeks Island is a shallow piercement-type salt dome, 15 miles south of New Iberia, Louisiana, and one of five similar domes in a line. The salt is 60 ft deep. Sixty-nine wells (forty-five producers, fourteen dry, nine drilling) have been put down in five years. In April the allowable was 11,335 b.d. Most of the drilling is done from barges. The discovery well was completed at 13,505–13,520 ft. G. D. H.

20. Gulf well is producing from Davis sand zone. Anon. *Petrol. Engr*, Apr. 1950, **22** (4), B-92.—1 Kinnebrew, in the Athens field, Claiborne Parish, Louisiana, on completion produced 257 b.d. of 52° condensate and 2,954,000 cu. ft. gas/day from the Davis sand from 8148–8186 and 8208–8233 ft. C. A. F.

21. Shallow sand in deep pool. Anon. *Petrol. Engr*, Sept. 1950, **22** (10), B-84.—A-7 Weeks Island State, on the Weeks Island Dome, Iberia Parish, Louisiana, flowed 127 b.d. from 3742–3750 ft from a sand pay. C. A. F.

22. Mississippi well completed. Anon. *Petrol. Engr*, Apr. 1950, **22** (4), B-92.—2 G. W. Armstrong, Wilkinson County, Mississippi, was completed for an initial production of 36 b.d. and 625 M.c.f. gas/day from the Wilcox sand. Total depth is 8370 ft. The well is in the Possum Corner field. C. A. F.

23. The search for oil and gas in the Rocky Mountain region. D. Hager. *Oil Gas J.*, 18.5.50, **49** (2), 116.—Montana with 15,000 ft of marine and lacustrine sediments may not be expected to have the potentialities of Wyoming with 40,000 ft. Thus Montana has eighteen pays, and Wyoming has over thirty-five, with further possibilities; Colorado has twelve known pays in 15,000 ft of beds and New Mexico ten pays in 15,000 ft. On the other hand, Utah with 45,000 ft of beds has now only ten pays; if the generalization holds good others may be expected in the Upper Cretaceous and Mesozoic. The thickness as well as the number of possible pays is important.

Structural traps have been the chief target in the Rocky Mountain area, but now more attention is paid to stratigraphic traps. Cutbank, Osage, and Huntsman are stratigraphic traps. Seismic techniques are not well enough developed to detect stratigraphic traps. The air-borne magnetometer has not given favourable results in this area. Careful investigation of surface and subsurface geological data may provide guides to discoveries. In eastern Montana and North Dakota it is hoped that Silurian and Devonian reefs will be found. Dips are very low in the Dakotas; there are a few surface structures in Tertiary beds. New pools should be found in northwest New Mexico. The San Juan basin should have stratigraphic and structural traps. The Denver basin offers the best possibilities in Colorado. Northeast Arizona has been little tested, but the Boundary Butte fold which produced from Permian and Pennsylvanian is near. Idaho has no commercial oil or gas production, but favourable rocks should be present, and there are structures worth testing. Nevada also has suitable conditions for oil and gas. G. D. H.

24. Four-state land play in Julesburg basin. C. J. Deegan. *Oil Gas J.*, 18.5.50, **49** (2), 189.—8–12 million acres of land are now estimated to be leased in the Julesburg basin. This play was begun by the Gurley discovery in Cheyenne County, Nebraska. There have been two further finds to the south and a little west. The pays are in the Dakota at 4500–5000 ft. Closure may be 50 ft or less, but not over 100 ft. The section is mainly shale and sand. The Gurley discovery was based on seismic work.

G. D. H.

25. Denton field gets its second well. Anon. *Petrol. Engr*, Apr. 1950, **22** (4), B-92.—1 L. R. Chamberlain in the Denton field, Lea County, New Mexico, on completion flowed 1092 b.d. from the Devonian from open hole at 11,501–11,513 ft. G.O.R. was 889 : 1. C. A. F.

26. Stratigraphical prospects in southwestern Oklahoma. C. A. Caswell. *World Oil*, Aug. 1950, **131** (3), 73.—A study of geological conditions along the southwestern flank of the Wichita Mountains, Oklahoma, indicates the possibility of stratigraphical oil accumulations in this area. The Walters field in Cotton County is the only field yet discovered where stratigraphy controls the accumulation.

Evidence for the existence of stratigraphical traps in this area include: a prominent north–south updip facies change towards the axis of the Wichita Mountains within the Cisco–Hoxbar–Canyon; Pennsylvanian onlap on the Arbuckle towards the mountain axis; numerous unconformities within the stratigraphical section converging towards the mountain axis; and a major hiatus between the base of the Canyon and top of the Arbuckle.

The Walters accumulation is primarily controlled by a facies change from sand to limestone.

It is probable that the axes of the Wichita Mountains and related structures are flanked by belts of stratigraphical traps in successively lower Pennsylvanian sections. Traps due to onlap may be present within the Pennsylvanian in the Marietta Syncline

and the Palo Duro Basin. Pennsylvanian truncation of the Mississippian may also provide effective traps.

Seismic work in the area has not been successful in delineating stratigraphical traps. Electrical log cross-sections and a structural map of the area are included. C. A. F.

27. Elk City well completed. Anon. *Petrol. Engr*, Sept. 1950, **22** (10), B-86.—1 Pyle, in the Elk City field, Beckham County, Oklahoma, on completion flowed 682 b.d. oil and 1,164,000 cu. ft. gas/day from a total depth of 10,040 ft. C. A. F.

28. Ohio oil proves deep gas field in Oklahoma. Anon. *Petrol. Engr*, Sept. 1950, **22** (10), B-88.—1 Jones, in northeastern Coal County, Oklahoma, on a second test flowed 4,500,000 cu. ft. gas/day through ½-in choke from Bromide dolomite at 8960–9042 ft. In the first test between 8840 and 9000 ft the well flowed about 5,000,000 cu. ft/day. C. A. F.

29. Permian basin third largest "Oil State." C. J. Deegan. *Oil Gas J.*, 27.4.50, **48** (51), 128.—In 1949 the Permian basin produced 14·7% of the U.S. output, thus ranking next below California, which was second on the list of producing states. The reserves of 5,800,000,000 brl represent 22·4% of the U.S. total and exceed those of California. The Scurry reef field opened in 1948 had proved reserves of 896,000,000 brl at the beginning of 1950.

The main structural features of the Permian basin are the Central basin platform, the Delaware basin to the west, and the Midland Black Shale basin on the east with the Eastern shelf or platform on the east of the latter basin. Westbrook, the first discovery, was opened in 1921 on the eastern platform; the first major discovery was Big Lake, opened in the Midland basin in 1923, and then activity was largely along the Central Basin platform. There are no outstanding fields in the Delaware basin. The principal development has been on the Central Basin platform, and to the north, with fairly extensive work on the Eastern shelf. In recent years there has been much activity in pre-Permian pays on the Central Basin platform, and Benedum indicates that local highs in the deep basins can produce.

Tables give 1949 production and reserves by fields, a summary of wildcatting by counties in 1949 and the first quarter of 1950, a summary by fields of 1949 and the first quarter of 1950, development drilling, and the cumulative outputs by fields, with the main producing horizons. There is a map of the top of the Canyon for the Scurry reef fields and a brief account of the discovery of these fields. G. D. H.

30. Permian basin sets dizzy pace. C. J. Deegan. *Oil Gas J.*, 25.5.50, **49** (3), 185.—A new Pennsylvanian reef discovery has been made in central east Hockley County, 4 miles south of Smyer. It is 12–15 miles east of Slaughter. The output may be 2000 b.d. of 41° oil from 9290–9320 ft.

In southeast Lynn County, 14 miles east of O'Donnell, a well has found 41° oil in a Pennsylvanian limestone D.S.T. at 8615–8630 ft. Chaves County, New Mexico, has a find 35 miles northeast of Roswell, where a well flowed 146 b.d. of 52° oil in 2½-hr from Devonian limestone at 7940–7978 ft; the G.O.R. was 1527. G. D. H.

31. Saskatchewan has discovery in new west-central area. Anon. *World Oil*, Oct. 1950, **131** (5), 232.—Heart's Hill 1, between Major and Heart's Hill, in west-central Saskatchewan, bailed 35 b.d. without lowering the 1400-ft oil column. Total depth of well was 3100 ft. From gravity data, the 42 ft unbroken sand discovered by the well is estimated to cover about 3200 acres. Pay is Lower Cretaceous and is the thickest yet found in the province. The oil is heavy and similar to that in the Lloydminster field. Lighter oil is expected updip.

Test wells have been drilled near Kerrobert, Richard, and Hafford, and a deep test is being drilled in the Mayfair area. C. A. F.

32. Prospective Pennsylvanian reef and non-reef areas of West Texas. J. H. Bartley and B. R. Haigh. *World Oil*, Sept. 1950, **131** (4), 73.—The active development in recent years of Pennsylvanian production in West Texas has indicated two broad reservoir types—"reefs" and "non-reefs."

The "reefs" are limestone build-ups with lateral variation from limestone to shale.

Accumulation is not primarily controlled by structure. Reservoirs of this type are developed in a belt along the Eastern platform, extending from Sutton to King counties, with an additional " Scurry " trend forming an arc whose limbs trend northwards, terminating in Hockley and King counties. Reefing is also found in isolated areas along the crest of the Matador uplift.

The " non-reef " reservoirs are limestones lithologically similar to the reef type, but there are no build-ups, and accumulations have a structural control. Such reservoirs may be developed along the east flank of the Central Basin platform, the southeastern flank of the North basin Platform of Yoakum and Cochran counties, and on the flanks of the Matador Uplift. A few fields have been found on the Eastern platform.

Oil gravities range from 35° to 60°. " Reef " reservoirs produce higher gravity oil than " non-reefs."

The history of the discovery and development of Pennsylvanian production is outlined. A map shows the distribution of " reef " and " non-reef " fields, and potential areas.

A table giving mechanical and production data of the fields is included. C. A. F.

33. Depth records set in Texas and Louisiana. Anon. *Petrol. Engr*, Sept. 1950, **22** (10), B-82.—1-E June Sanders in the Sweetie Peck field, Midland County, Texas, on completion flowed 909 brl from the Ellenburger from 13,245–13,290 ft.

2 Weeks Gal State Unit, on the north flank of Weeks Island Dome, Iberia Parish, Louisiana, flowed 247 b.d. from 15,122–15,137 ft. C. A. F.

34. Texas Gulf coast adds two new pools. Anon. *Petrol. Engr*, Sept. 1950, **22** (10), B-84.—1 John Kalcak, Wharton County, Texas, on completion flowed 170 b.d. from 6562–6568 ft. G.O.R. was 477 : 1.

C-1 State, Brazoria County, Texas, on a 20-hr test flowed 50·5 brl oil, 2·5 brl mud, and 1 brl brine from 7122–7136 ft. C. A. F.

35. Bee County discovery made. Anon. *Petrol. Engr*, Apr. 1950, **22** (4), B-94.—1 Roberson, Bee County, Texas, flowed 144 b.d. of distillate and 3,340,000 cu. ft. gas/day from the Luling sand in the Carrizo Wilcox, and 3,266,000 cu. ft. gas/day from the Massive sand. The well is 5 miles southwest of the Caesar field. C. A. F.

36. Old Ocean test closely watched. Anon. *Oil Gas J.*, 22.6.50, **49** (7), 349.—Old Ocean Unit 20 B.R.L.D. is drilling below 12,458 ft in Texas. The field has five commercial zones in the Frio at 9000–11,000 ft, two having gas-condensate and two a commercially important oil rim. 20 B.R.L.D. is intended to search for deeper reservoirs. Old Ocean was one of the first deep high-pressure fields to be developed. G. D. H.

37. Scurry reef play jumps southwest. C. J. Deegan. *Oil Gas J.*, 23.2.50, **48** (42), 219.—In southwest Borden County, 1 Reinecke flowed 24 brl of oil in 30 min from the Canyon at 6754–6784 ft. 1 Griffen topped the reef at 6940 ft, some 200 ft lower than estimated, although it is not yet proved to be a failure. 1 Reinecke is about 5 miles south-southwest of the known nearest reef oil in Borden County, and this is 4 miles west of Sharon Ridge.

The trend may be almost 40 miles long, and at present appears to have the third largest U.S. oilfield. G. D. H.

38. More reef production found in Kent. Anon. *Oil Gas J.*, 15.6.50, **49** (6), 153.—The Hunt-Young field of west-central Kent County, Texas, appears to be a sizeable Canyon reef producer. The second well met the reef at 6217 ft, 103 ft higher than in the first. The output was 645 b.d. on a ¾-inch choke from 6464–6516 ft. ½ mile south of the discovery 2 Young flowed 726 b.d.

An offset producer has been drilled in the Clairemont field. Production is probably Pennsylvanian.

4½ miles northwest of the Cogdell field 1-C Wilson Connell recovered oil in a drillstem test at 6845–6870 ft. G. D. H.

39. Midland County well is Ellenburger discovery. Anon. *Petrol. Engr*, Apr. 1950, **22** (4), B-92. 1-E Peck, 4 miles west of the Pegasus Ellenburger field, Midland County, Texas, on completion flowed 1056 b.d. of 53° oil from the Ellenburger limestone from 13,128–13,245 ft. The well was acidized. C. A. F.

40. New Midland field. R. F. Carlson and C. F. Hoot. *Oil Gas J.*, 22.6.50, **49** (7), 150.—The 2 Roy Parks wildcat in Midland County, Texas, has indicated 3000 b.d. in an Ellenburger drillstem test at nearly 13,000 ft. It lies 12 miles north of Pegasus. The structure is believed to be similar to Peck and Pegasus. A good gas flow was obtained in a test in the Wolfcamp at 9525–9600 ft, and oil was recovered. A Pennsylvanian test at 10,398–10,468 ft flowed 44·6° oil. G. D. H.

41. Pegasus and Meadows fields. F. Shepherd and M. E. Wilson. *Oil Gas J.*, 27.4.50, **48** (51), 140.—The Pegasus field was opened in 1949 with 975 b.d. from the Ellenburger at over 12,000 ft. The Meadows field was opened with 1056 b.d. at 13,128–13,250 ft. These fields are now the sites of intense deep-drilling programmes. Surface and subsurface geological studies were checked by core holes to the Yates at about 2650 ft, and these confirmed the existence of a shallow structure. After some deep drilling a detailed reflection survey was carried out in 1947–48, and on the basis of this the Pegasus discovery was located. Some shallow dry holes and a seismic survey preceded the Meadows discovery.

Both fields are being drilled on 40-acre spacing. The Ellenburger is being developed at Pegasus and the Ellenburger, Devonian, and Pennsylvanian are being developed at Meadows. Both have had Permian and pre-Permian shows of oil and gas. The shallowest was in the Spraberry sand at 7770–7980 ft.

The Woolcamp had shows. The Pennsylvanian had shows at 10,310–10,428 ft. Fractured Devonian limestones gave shows at 11,800–12,200 ft. Some saturation was noted in the Fusselman (Silurian) at 12,464–12,548 ft. In the Meadows field the Ellenburger oil was at 13,128–13,338 ft, and was 53° gravity.

The productive limits and thicknesses of the oil columns in the various horizons are not yet known. Recoveries of over 75,000 brl/acre are expected.

Both fields have similar stratigraphic columns. At the surface is Pliocene, then Lower Cretaceous (200 ft), Triassic (1400–1500 ft), Permian (8300–8750 ft), Pennsylvanian (1100–1400 ft), Woodford, Devonian (700–860 ft), Silurian, and Ordovician. Pegasus and Meadows are asymmetrical folds elongated north–south.

Drilling conditions are briefly described; typical logs, a cross-section, structure map, and a correlation table for the wells are included. G. D. H.

42. Drilling in Western Nebraska. W. L. Herschman. *Oil Gas J.*, 4.5.50, **48** (52), 146.—Cheyenne County is in the Julesburg basin 80 miles southwest of the Chadron Arch. The dip continues westwards or southwest for a further 100 miles. There is a cover of about 1000 ft of Tertiary masking the Cretaceous structure. 50 miles to the northwest in Garden County, a well drilled through Morrison, Permian(?) and Pennsylvanian, and into Pre-Cambrian.

The Cretaceous is petroliferous in the Julesburg basin, and has potential reservoir rocks. As a result of seismic work favourable structural conditions were indicated in Cheyenne County. The Gurley field has over 100 ft of independent closure. Ten wells have been drilled, seven finding oil. Six produce from the first bench of the Dakota, and one from the third bench. The wells average 100 b.d. on the pump. The sands have shale breaks. Porosities average over 17%, and some permeabilities exceed 1000 mD. The oil is 35° gravity, with 0·24% sulphur.

8 miles southwest of the Gurley field is the Huntsman gas field with 100 ft of closure. Gas occurs at 4744 ft in the third bench of the Dakota. The discovery well gave 54,000 M.c.f/day. A later well showed oil in the top bench, and the third bench. G. D. H.

43. Leduc oil field broadened. Anon. *Petrol. Engr*, Sept. 1950, **22** (10), B-86.—Dewar 1, 2½ miles southeast of the Leduc field, Alberta, found oil which hit surface in 49 min. C. A. F.

44. Bolivar geosyncline of northwestern South America. W. E. Nygren. *Bull. Amer. Ass. Petrol. Geol.*, **34** (10), 1998–2006. Prepared to aid paleobotanists and

paleontologists in their study of the problems of migration and intermingling of floras and faunas between North and South America.

The Bolivar geosyncline extends through coastal Ecuador and Colombia from southwestern Ecuador to the Golfe de Uraba. Six cross-basin highs separate the deeps within the trough. Marine sedimentation began in the south in the middle Eocene, gradually encroached northward, and continued intermittently on into the upper Miocene. Several unconformities of varying importance are present. Post-Miocene sedimentation is mostly non-marine. During the early Tertiary the sediments were largely derived from the west, but after the Lower Miocene they were mostly from the east. Migration of terrestrial animals could have taken place through this area during the periods from Upper Cretaceous to Middle Eocene, Middle Oligocene, Lower Miocene, and the Upper Miocene to Recent. E. N. T.

45. Brazil's Amazon basin to get first deep test. Anon. *World Oil*, Oct. 1950, **131** (5), 230.—A deep test is being drilled on a prominent anticline on the west bank of the Tocantins River, about 75 miles southwest of Belem, Para, in the Amazon basin.

Geological and geophysical work in the area has shown sediments probably over 10,000 ft underlying the western half of Marajo Island, and extending southwards under the lower valleys of the Tocantin, Moju, Acara, and Capim Rivers. Beds are much faulted in a north–south direction. The main fault extends from the Rio Capim Valley northwards across Marajo Island. C. A. F.

46. Deep test finds oil. Anon. *Oil Gas J.*, 27.4.50, **48** (51), 85.—The Alturitas wildcat in Western Venezuela has recovered oil in a drillstem test below 15,777 ft. G. D. H.

47. Trinidad discovery. Anon. *Oil Gas J.*, 1.6.50, **49** (4), 47.—Small quantities of oil and gas have been found in a 5000-ft well in the northern half of Trinidad near Manzanilla Beach. The well is under test, but the prospects are not rated highly. G. D. H.

48. The development of geological knowledge on the pre-Pyrenean basin and the discovery of the Lacq oil field. E. G. Bonnard. *Rev. Inst. franç. Pétrole*, July 1950, **5** (7), 203–11.—In 1943 palæogeographical maps for the Upper and Lower Cretaceous were published by Gubler. There was an east–west trough in Lower Cretaceous time, and in it 4000 m of sediments were deposited. In Upper Cretaceous time the trough was closed in the east and it deepened westwards. Deposition totalled 4000 m. There is a based Flysch breccia which is the St Marcet reservoir.

Electrical prospecting outlines a number of structures, and the axes were parallel with those of the Petites Pyrénées. Garlin, the first structure on which deep prospecting was undertaken, was in the zone of marginal Lower Cretaceous deposits. The Audignon anticline and the Bastennes diapir were examined before 1949. None of the wells found Upper Cretaceous below the Flysch facies. Each of the structures had a Triassic diapiric core with little or no Cretaceous over it. The Garlin, Audignon, and Bastennes wells had asphalt shows at the base of the Lower Cretaceous and light oil above.

Since 1947 it has been considered that reservoir rocks could occur in the Jurassic, infra-Liassic, and Permian. These should be sought on the flanks of the diapirs or on shallower structures to the north, while neo-Cretaceous reservoirs should be sought to the south.

Gravity work indicated two anomalies in the region of Pau. At the end of 1949 it was decided to examine seismically the southern flank of the Amou syncline against the Puyoo fault and the gravimetric anomalies. The first profile showed the Lacq high, and the second confirmed one of the gravity anomalies. Four profiles gave the isochrons for the Lacq structure at three horizons. The structure was slightly elongated northwest–southeast. There was doubt about southwest closure, and surface geology did not clearly resolve this problem. Three shallow holes confirmed the southwest dip. The seismic sections indicated several angular discordances. The first well showed the Ypresian marls to be reduced to 300 m and to rest on Campanian limestones, thus confirming the presence of structure. Paleocene, Danian, and Maestrichtian were absent, pointing to up-lift between Campanian and Ypresian time. G. D. H.

49. First studies of the Lacq field. P. Maugis. *Rev. Inst. franç. Pétrole*, July 1950, 5 (7), 212.—The discovery well was on the crest of a seismic anomaly. Miocene masks the deep structure to a depth of 260 m. Beneath the well found 255 m of Ypresian marls, 38 m of Campanian breccia, and then grey, pyritic, glauconitic Campanian limestone, and clay with sandstones at 635–640 m depth. The oil zone extended from 640 m down to the bottom of the well at 695 m. This zone has two forms, one being compact with little dolomite and the other fractured and very dolomitic. The former has a porosity of 15–20% and permeability of 10–12 mD; oil saturation is 50–60%. Well No. 1 gave 30 m^3/day. The latter form occurs in No. 2 and No. 4 and has low porosity and permeability, but the formation gave 46 m^3/hr in No. 2.

The subsurface pressures at Lacq and Garlin are almost the same.

The four wells are on the northeast flank of the structure.

A series of logs and correlations are given, together with a cross-section through Lacq and Garlin. G. D. H.

50. Pechelbronn area enters new expansion. E. A. Bell. *World Petrol.*, Aug. 1950, 21 (9), 36.—The Pechelbronn workings covering 61,775 acres have given 3,000,000 metric tons of oil in sixty years from discontinuous irregular Tertiary sands. 186 miles of tunnel have been excavated, and 5000 pumps installed. Output in 1937 was 70,250 metric tons of crude and 27,291 tons in 1945; eleven months of 1948 yielded 48,141 tons.

In July 1949 oil was found at Soultz-sous-Forets in Triassic limestone at 2830 ft. An output of 6300 b.d. has been reported. In 1947 a well drilled through the Pechelbronn Tertiary zone gave 750 b.d. from a deeper formation. Further development is planned. G. D. H.

51. Progress in Italy. Anon. *Oil Gas J.*, 25.5.50, **49** (3), 99.—A natural gasoline plant is planned for the Cortemaggiore field. Twelve rigs and six seismic crews are now operating in the Po Valley.

The Cortemaggiore discovery well flowed 175–200 b.d. of 35·4° A.P.I. oil from 5000 ft. A later well gave 600 b.d. initially. Seven wells have been completed. There is a 7½-mile east–west structure in Upper Miocene. Caviaga (Lodi) has seventeen producers at 5000–6000 ft. Over 30,000,000 cu. ft. of gas is produced daily and piped to Milan and Bergano. The pay is 650 ft thick and covers nearly 3000 acres. Ripalta is like Caviaga. Podenzano was opened in 1931 and has thirty Middle Miocene gas wells, which together with fourteen on the San Giorgio structure yield 500,000 cu. ft/day. G. D. H.

52. Pickup in Germany. Anon. *Oil Gas J.*, 11.5.50, **49** (1), 56.—German oil reserves have recently been placed at 21,700,000 tons proved and 14,800,000 tons probable, a rise of 150% above figures given at the end of 1948. Nine oilfields have been discovered since the end of 1948. Two are on deep structures between salt domes. 981,000 ft was drilled in 1949, and 42% of the holes drilled were wildcats or extensions. Seismic work showed good results.

Ruehlertwist–Ruehlermoor is an anticline outlined by reflection work. The discovery well gave 284 b.d. from the Bentheim sandstone at 2560 ft. An area 6 miles by 2½ miles with reserves of 12,500,000 tons has been outlined. Schierhorn is a stratigraphic trap in the Bentheim sandstone at 3700 ft. Suderbruch lies between salt domes and yields oil from the Cornbrash at about 6700 ft. Reserves of 3,500,000 tons are estimated. Eldingen appears to be of the same type as Suderbruch, with oil in the Lias. A little heavy oil output was obtained from the Lower Dogger at Hohenhorn. Quakenbrueck first gave commercial production at 1500–1900 ft in January 1950.

The Heide field has been extended, and also the Neinhagen–Haenigsen and Weingarten fields.

In 1949 Germany produced about 16,300 b.d. The average price was D.M. 120/ton (about $4·1/brl). G. D. H.

52a. Danish-American firm contracts for new concession in Denmark. Anon. *World Oil*, Oct. 1950, **131** (5), 238.—A Danish-American company has acquired a new fifty-year concession of 17,000 sq. m. in Denmark.

110 structure wells have been drilled in Denmark in recent years and a dry well in North Jutland, near Frederikshavn, found basement at 4317 ft. The Gassum 1 well, now at 9955 ft, is to be deepened.

Exploration in Denmark commenced in 1935, when two wells were drilled. The second of these found salt. A small field in glacial drift was discovered in North Jutland. German operators found oil south of the Danish border, at Heide, before the war. C. A. F.

53. Foraminifera of the "Flisz" formation of Silesia Facies on the marginal (border) of lower and upper cretaceous (rock). J. Czernikowski. *Nafta*, July–Aug. 1949, **5**, 177–80.—Describes fossils found in "Godulka" rock. These are also found in Silesian Lower Carpathians. There is a similarity between Carpathians and Caucasus in their fossilized deposits. M. S.

54. Oil from Qatar. Anon. *Oil Gas J.*, 26.1.50, **48** (38), 166.—The Qatar concession was granted in 1935, and the first well was spudded in 1939. The well was completed in 1940 for 5000 b.d. After drilling three wells drilling was suspended until 1947, and now Dukhan has nine producing wells. The Qatar peninsula is a broad low anticlinorium, the Dukhan field being near the western shore and near the base of the peninsula. This structure is 50 miles long and 5 miles wide, with 300 ft of closure. Beneath surface sand Eocene limestones occur. Oil was found in the No. 3 limestone of the Jurassic Zekrit formation. The No. 4 limestone has gas.

Salt-water mud is used in drilling. In the Eocene there are no returns. The cap rocks are anhydrites. G. D. H.

55. Second Neutral Zone well dry. Anon. *World Oil*, Aug. 1950, **131** (3), 246.—The second well drilled in the Neutral Zone between Kuwait and Saudi Arabia has been abandoned as dry. The first well, to the east, was abandoned at 5202 ft in 1949. C. A. F.

56. Africa. Anon. *Oil Gas J.*, 25.5.50, **49** (3), 101.—The Sidi Aissa area of Algeria gives about 130 b.d. from ten of the fourteen wells drilled to about 1000 ft. It is planned to drill nearly 40,000 ft in 1950, and to enlarge the refinery to 750 b.d. Production comes from a zone at 600–1000 ft, and a second at 2000 ft. The discovery was made in 1949. G. D. H.

57. Tough wildcats. Anon. *Oil Gas J.*, 27.4.50, **48** (51), 81.—Sinclair 1 Gumburo, in the Ogaden desert of southeast Ethiopia, was abandoned at a depth of over 10,000 ft. It penetrated 1800 ft of igneous rock and then several thousand feet of limestone and anhydrite streaked with shale. An extensive geophysical programme is under way, and a second test is expected to be drilled. G. D. H.

58. Pakistan test suspended. Anon. *Oil Gas J.*, 23.2.50, **48** (42), 126.—The Lahkra test encountered large volumes of high-pressure water at 12,666 ft and has been suspended. Gas shows, but no commercial oil and gas have been found. G. D. H.

59. Hopeful wildcat. D. M. Duff. *Oil Gas J.*, 11.5.50, **49** (1), 58.—The Barsilla wildcat, 14 miles south of Sibsagar in Assam, has had oil shows in sands at about 4000 ft. It is on one of the few untested structures in the Assam Valley area. G. D. H.

60. Japanese find. Anon. *Oil Gas J.*, 23.2.50, **48** (42), 126.—Yabase has two good reservoirs below Zone 8. Koya R-34 flowed 2000 b.d. of oil and emulsion. Its depth is 6275 ft. G. D. H.

Geophysics and Geochemical Prospecting

61. Geophysical activity. E. A. Eckhardt. *Oil Gas J.*, 27.4.50, **48** (51), 104.—In 1949 world geophysical activity was at least as high as in 1948. The U.S.A. had 74·87% of the seismic work, Canada 9·54%, and South America 6·29%; the U.S.A. had 53·4% of the gravity meter activity, Canada 12·11%, Venezuela 5·25%, Europe 5·56%, and Africa 3·48%. In the U.S.A. Texas had 44·4% of the seismic work, the Rocky

Mountain states 17·7%, Louisiana 16·2%, Oklahoma 9·3%, and California 3·2%. Texas had 34·81% of the gravity meter activity, Louisiana 17·27%, and the Rocky Mountain states 29·95%.

Graphs show the numbers of seismic and gravity meter parties operating in the U.S.A. throughout the years from 1940, while proved reserves added are compared with the monthly variation in seismograph crew-months from 1932. Although the peak seismic activity in recent years has been about twice the peak activity in the late thirties, the oil discoveries have been only at about the same levels. This suggests the influence of the law of diminishing returns. G. D. H.

62. Seismic work problems in the Canadian bush country. W. J. Tillington. *Oil Gas J.*, 27.4.50, **48** (51), 114.—In seismic work over reefs the reflections from above and below the reef diverge in going away from the reef, whereas the reverse is true for the geological markers. This is a consequence of high-velocity material in the reef. Reflection character changes associated with facies changes at depth can be influenced by surface changes.

The procedure adopted comprises: (1) a detailed velocity survey in a stratigraphic test hole; (2) velocity surveys in 400–900-ft holes spaced at about 10-mile intervals to give near-surface velocity changes; (3) networks of township-size loops join the deep tests; (4) within these standard loops there is shooting for isopach data.

It is believed that with suitable organization and equipment the cost may be $400/mile or $50/profile for spring, summer, and autumn operations, provided that record quality is above average. G. D. H.

63. Canadian bush country and its demands on geophysical equipment. C. J. Deegan. *Oil Gas J.*, 15.6.50, **49** (6), 90.—In the northwest of the Alberta basin the country is heavily timbered in places with swampy areas interspersed. Soft and muddy ground may occur even where there is no muskeg. In winter the temperatures may be −20° to −40°, and daylight is short.

Muskeg should be avoided if at all possible. It may be up to 80 ft thick. Seismic records across muskeg are generally rather poor, whether in summer or winter.

Elsewhere it is impracticable to work where the surface will not support a man with a load on his back, and vehicles must be designed accordingly. Trails must be cut, at a cost of $40–$300/mile. Water may have to be carried. Surveying is done from a tractor or jeep. A Fordson tractor with winch and heavy front grille has been employed. A track-laying tractor with brush cutters has been used in clearing, a chain saw being carried to deal with larger trees. A trailer camp is difficult to move, and so a special trailer has been designed in which case equipment for sleeping out is necessary.

In winter the water-tank for the drill must be heated. G. D. H.

64. Western Canadian plains—a new challenge to geophysics. A. F. Beck. *Canad. Min. metall. Bull.*, Mar. 1950 (455), 132.—Prospective oil territory in Western Canada totals some 655,000 sq. miles. Gravity work has been done over a great part of the western plains area, but there are difficulties in interpretation. Greater knowledge of densities, thicknesses, and regional structure may help in this connexion. The ground magnetometer has been used to a small extent. The seismic method has proved successful, although there are interpretational problems. Lateral velocity variations are important, and reefs distort time values. Velocities are inverted in the weathered zone, especially in rugged areas. Geological interpretation of the data is of prime importance.

Apart from transportation difficulties temperatures of −40° to −60° are met in some areas. Experiments are being carried out with surface shooting. Over $16,000,000 was spent on geophysics in Canada in 1949. Thirty-four discoveries (twelve oil, twenty-two gas) were made out of 184 wildcats. Most of the wildcats were based on seismic data. G. D. H.

65. Surface minerals reflect subsurface structure in new exploration technique. B. H. Lasky. *World Oil*, Oct. 1950, **131** (5), 73.—There is a close relationship between critical minerals found in surface formations and underlying structure. Statistical quantitative studies of surface mineralogy have shown that alteration of surface sediments has occurred and that it is a function of subsurface conditions. These studies have been

useful in determining subsurface structure in the Texas Gulf Coast and Louisiana and Mississippi. Structures mapped include salt domes, high and low relief structures, faulted structures, and stratigraphical traps.

The technique involves sampling surface sediments from depths of 4–12 ft. Quantitative mineral compositions of the samples are then determined and differences between these and predetermined critical mineralization values of the samples are plotted, giving mineralization maps contoured on an arbitrary datum.

Results indicate that this technique may be useful in structural mapping where conventional methods have been unsuccessful or inconclusive.

Eleven references are given. Examples of mineralization maps are included.

C. A. F.

66. Porosities can be obtained from radioactivity logs in West Texas. R. E. Bush. *Oil Gas J.*, 27.4.50, **48** (51), 153.—A radioactivity log run in a cored section provides data for a neutron-derived porosity curve—the arithmetic average of the neutron deflections in relation to the corresponding porosities. It may be necessary to determine from the same data a γ-ray subtraction curve to correct for shale in the formation. Provided that hole size, casing programme, and lithology are the same in other wells these curves can be applied. First a reference line must be established on the logs, and for the Scurry area averaging of the shale line immediately above the Canyon is satisfactory. Deflections and porosities are tabulated, and for deflections below a critical value a semi-logarithmic plot is made to give the neutron-derived porosity curve.

Where shale affects the neutron curve combined water will give a higher neutron value than corresponds with the porosity. The correction is related to γ-ray deflections. Corrections must also be made for differences of log sensitivity.

An example of the application of this technique is given, together with various logs and tabulations. G. D. H.

67. The microlog—a new electrical logging method for detailed determination of permeable beds. H. G. Doll. *Petrol. Tech.*, June 1950, **2** (6), *A.I.M.M.E. Tech. Paper No.* 2880, 155–64.—The micrologging technique employs electrodes 1–2 inches apart, mounted in a rubber pad and pressed against the well walls. Measurements are recorded simultaneously for two different spacings. The resistivity measurements comprise small volumes of material—mud cake and mud-invaded rock. The behaviour of the two curves is diagnostic, and the method provides a very detailed record of the formations and particularly of the permeable beds encountered. The method is of value in locating permeable zones in compact formations, such as limestone, and to determine the amount of sandstone in interbedded sandstone-shale sequences.

Details of the method of interpretation are given, some examples are discussed, and possible further developments are considered. G. D. H.

Drilling

68. Chemicals used in red-lime muds. O. W. Van Dyke and L. M. Hermes, Jr. *Industr. Engng Chem.*, **42** (9), 1901–5. (*5th S.W. Mtng. Amer. Chem. Soc., Oklahoma*, Dec. 1949.)—The effect of clay solids on solutions containing quebracho, caustic soda, and lime has been studied to determine the effect of formation solids upon red lime muds which are used in drilling operations and contain such chemicals. Visc curves are given which show that the chemicals present have a marked effect on visc–solids relations for a single clay. Combinations of the chemicals in red-lime mud have much greater effect than the same compounds used singly. This is borne out in field drilling practice. Results suggest that solutions of these chemicals act as powerful dispersing agents which have a marked effect on clay solids and will have wide application by their resistance to viscosity build-up in drilling. R. G. T.

69. Bentonite suspensions—effect of sodium chloride, sodium hydroxide, quebracho, and sodium carboxymethyl cellulose upon physical properties. W. E. Bergman and H. B. Fisher. *Industr. Engng Chem.*, 1950, **42** (9), 1895–1900. (*5th S.W. Mtng. Amer. Chem. Soc., Oklahoma*, Dec. 1949.)—Many aqueous drilling muds are prepared with bentonite by treatment with caustic soda and quebracho. Extensive tests are

described to show the effect of caustic soda or quebracho or both on a 4·8% bentonite suspension. Effect of salt, frequently encountered as a contaminant, and of sodium carboxymethyl-cellulose (used as an additive to reduce water loss and control physical properties) were studied. Results show that, with less than 10,000 p.p.m. of salt, caustic soda and quebracho are effective controllers of visc and gel strength. Sodium carboxymethyl cellulose, as an additive, results in low water-loss, and facilitates the effect of quebracho and caustic soda on physical properties when salt concns. >10,000 p.p.m. are encountered. R. G. T.

70. New dip-logging method. F. G. Bouchier, A. B. Hilderbrandt, and H. B. Hagen. *Bull. Amer. Ass. Petrol. Geol.*, **34** (10), 2007–26.—The authors describe a new method of determining the dip and strike of subsurface formations in the earth from measurements taken in a single bore hole. The importance to the oil geologists of knowing the attitude of the formations traversed by a wildcat drill hole needs no emphasis. Much thought has been given to the problem of obtaining this type of information since the significance of subsurface structure has been realized. Although some progress has been made, it was generally felt that there was room for considerable improvement. Work on this problem during the past 2½ yr has resulted in the development of a method of determining dip and strike based on profiling the walls of the bore hole.

The new method is based on the fact that the drilling process erodes some formations more than others. A log is made of three simultaneous profiles of the bore-hole wall which are oriented with respect to compass north. These profiles enable measurements to be made of the vertical displacements of the edges of hard strata protruding into the bore hole. From these measurements and from continuous measurements of inclination and direction, the dip and strike of the subsurface formations can be calculated.

An extensive field-testing programme has proved the principles involved to be sound. During this field work, dips ranging from zero to 75° were measured. It was found possible to re-log a given well and reproduce approx 70% of the final dip results with 2°. From such results it is concluded that the profile method of measuring the dip of subsurface formations is sound and of considerable value in the study of subsurface geology. E. N. T.

71. New method of correlation by resistivity values of electrical logs. A. P. Claudet. *Bull. Amer. Ass. Petrol. Geol.*, **34** (10), 2027–60.—The new correlation technique consists in making use of the numerical values of shale resistivities for the elucidation of structural problems. Cross-sections showing the subsurface correlation derived from electrical logs recorded on wells spaced over large distances throughout Louisiana, Mississippi, and Alabama are shown, illustrating the progressive variations of shale resistivities which occur with changes in locations or geological age. These clay or shale resistivity values may be correlated over considerable distances under favourable conditions, but they are particularly useful in short-range correlations under faulted-field conditions. E. N. T.

72. Radioactivity well logging. S. L. Sulimirski. *Nafta*, Dec. 1949, **5**, 334–9.—The theory is expounded of logging by use of γ-ray recordings. A description of a test in a well cutting through well-known formations follows, and thus intensity of radiation was compared with known geological profile. The result is compared with Soviet, German, and American results. Reputed as the best method γ-ray logging is also capable of discovering faults in casing, cement, movement of water, and oil in old completed wells. It can be used where electrical logging would fail. M. S.

73. Analysis of formation samples. Z. Wyszynski. *Nafta*, July–Aug., Oct., and Nov. 1949, **5**, 169–76, 260–6, and 293–7.—A complete description of procedure to be adopted for sampling rock (coring), preservation and transportation of samples, and testing. Nine tests are described, apparatus being sketched, and formulæ and a sample report are given. M. S.

74. Patents. R. D. Dawson, assr to Shell Development Co., U.S.P. 2,509,588, 30.5.50. A drilling fluid for wells made up of a major quantity of water and mineral oil emulsified therein, a finely divided solid weighting material dispersed in the

emulsion and an emulsifying agent for stabilizing the emulsion against brine contamination, this emulsifying agent being the reaction product of a basic reacting agent capable of forming a water-soluble soap with lauric acid.

F. W. Rolshausen and S. E. Swain, assrs to Standard Oil Development Co., U.S.P. 2,509,883, 30.5.50. A coring and fluid-sampling device moving along a drill stem and simultaneously taking a side-wall fluid sample and a side-wall core sample through a core bit.

R. W. Swinehart, assr to The Dow Chemical Co., U.S.P. 2,510,153, 6.6.50. A drilling fluid stable in the presence of brines rich in polyvalent cations, where for each barrel of mud is dissolved from 1 to 5 lb of a carboxymethyl methyl cellulose salt. C. F. S.

Production

75. Prediction of production behaviour in air-gas drives. R. F. Nielsen. *Producers' Monthly*, Dec. 1949, **14** (2), 29.—Two main differences between water and air-gas drives necessitate a modification in the approach to the theoretical background: the visc of water is about fifty times that of air, and the form of the relative permeability–saturation graphs is reversed in the case of air-gas drive, since the driving medium is the non-wetting phase.

A mathematical approach to the mechanism of air-gas drive has enabled the author to consider an example of a five-spot pattern, and to compare the theoretical results with actual production data. It was stated, consequently, that an approach to the practical solution was possible.

Eight graphs and references. A. J. H.

76. Subsurface projection of Cambro-Ordovician sediments in the Pennsylvania–New York region, and the relation to oil and gas possibilities. F. M. Swartz. *Producers' Monthly*, Sept., Oct., Nov., Dec. 1949, **13** (11), 25; **13** (12), 28; **14** (1), 25; **14** (2), 34.—Interest in the possibilities of petroleum reserves in deeper rocks has arisen following the decline in oil and gas production from the Devonian and Carboniferous sands in the Pennsylvania area.

This extensive survey of these sediments investigates the accumulation of petroleum in the rocks, from the viewpoint of its formation therein. The extent of exploration is not considerable, but further drilling may yield information of importance. Preliminary isopachous and sectional maps are reproduced.

The bibliography is recommended for further study. A. J. H.

77. Residual water and residual oil by capillary pressure technique. C. D. Stahl and R. F. Nielsen. *World Oil*, Aug. 1950, **131** (3), 160.—Curves showing capillary pressure–saturation relationships were obtained from a number of Bradford, Berea, and Venango sand cores. Experiments included the displacement of water by oil, followed by a water flood on the complex.

It was found that the "irreducible minimum" water saturation for the Bradford cores was generally higher than the saturation found by routine analysis. This was attributed to phase discontinuity and very small relative permeabilities at limiting saturations.

The Bradford and Berea sands were not definitely water wet, but the oil–water curves for the Venango cores showed preferential wetting by water.

There was a tendency towards higher residual water saturations with lower permeabilities in water-wet cores. C. A. F.

78. Practical considerations in the use of amine type water treatment. W. E. Howell. *Producers' Monthly*, Oct. 1949, **13** (12), 14.—The necessity for careful operation of such treating systems arises from the solubility characteristics of the amines.

Two systems in current use are described with emphasis on the practical details of operation. The installation of the feed pump ahead of the filter, although not of wide application, has the advantage that it reduces organic growth in the filters. The preliminary cleaning of the sand face by sodium hypochlorite and the control of the corrosive properties of the water are also mentioned. A. J. H.

78a. The function of water flood patterns. T. C. Canan. *Producers' Monthly*, Oct. 1949, **13** (12), 6.—The extensive coring of wells in the Bradford Field has enabled the pattern of water flooding in that area to be studied.

The original theory of water flooding was based on the assumption of homogeneity of the reservoir sand. In fact, the pattern of well location, which directly affects the flow of fluids, should be designed to correspond with the natural conditions of the field. Although the estimation of the reservoir characteristics can be commenced only after the drilling of certain wells, general trends of field characteristics may appreciably assist the more advantageous location of wells.

The problems are studied with particular reference to a property in the Bradford field. A. J. H.

79. A study of the effects of connate water saturation on water flooding. A. T. Sayre and S. T. Yuster. *Producers' Monthly*, Oct. 1949, **13** (12), 19.—Since it is generally accepted that reservoir rocks were originally laid down in water, the importance of connate water saturation in water-flood mechanisms cannot be over-emphasized.

Tests were conducted on a synthetic core of 37·8% porosity and 1·51mD brine permeability. The apparatus, which is described in detail, consisted essentially of a core body, a mixing head for the injection of oil–water mixtures, and other units for the measurement of pressure and saturation. The water saturations were obtained from prepared conductivity graphs.

The conclusions are given. The behaviour of the flood front was found to be dependent on the conditions prevailing, relative to the critical water saturation.

Nine graphs and references. A. J. H.

80. Low pressure mercury injection of reservoir sands. J. H. Henderson. *Producers' Monthly*, Nov. 1949, **14** (1), 32.—The study of pore-size distribution in cores and drilling samples was promoted for the development of a routine analysis in secondary recovery.

Particular attention was paid to pore sizes of radii between 1 and 10 μ, since these were found to be of greater importance in flooding systems. The study of the permeability relationships required the knowledge of too many factors to justify its practical application. The flood capabilities of cores could be estimated; data from tests were compared to field conditions.

The possibility of the application of the use of these tests on drill cuttings was not great, because of the effect of the bulk surface of the sample.

The apparatus is described, and the experimental procedure and interpretations of graphs given. References are appended. A. J. H.

81. Increased oil recovery by means of water injection pressure maintenance. W. L. Horner. *Producers' Monthly*, Dec. 1949, **14** (2), 15.—A clear distinction is made between water flooding and pressure maintenance by selective injection of water in the early stages of production of an oil pool. The advantages of the latter include a greater ultimate recovery, higher permissible production rates, and a reduction in the number of wells required.

Various fields are considered. The first pressure maintenance system of this type was commenced in 1943, and it is estimated that the production, under natural drive of 28 million brl, will now be in the region of 75 million brl. Since injection was started a production of 16·3 million brl has been accompanied by an increase in pressure from 2659 to 2703 p.s.i.

Extensive information is supplied in the form of geological maps and graphs relating to reservoir behaviour. A. J. H.

82. Relative productivity of perforated casing. 1. R. A. Howard and M. S. Watson. *Petrol. Tech.*, June 1950, **2** (6), *A.I.M.M.E. Tech. Paper No.* 2851, 179–82.—An electrolytic model study has been made of the relative productivity of perforated casing. The results show that the relative productivity is $\frac{1}{2}$ to $\frac{3}{4}$ of that predicted from point sink computations. The latter assumes in effect flow into a hemispherical cavity in contact with the opening in the casing, and this differs from flow into a circular hole; the ratio of the two rates is $\pi/2$. When the geometry of Muskat's assumptions (spherical sinks) was applied in the experiments good agreement with

Muskat's computations was obtained. The relative productivity was found to be insensitive to spatial arrangement of the perforations. G. D. H.

83. Dynamometer charts and well weighing. L. W. Fagg. *Petrol. Tech.*, June 1949, **2** (6), *A.I.M.M.E. Tech. Paper No.* 2854, 165–74.—The polished-rod dynamometer is employed in measuring loads, torque, and horsepower, and to determine pump action and locate trouble in any seemingly abnormal pumping condition. A series of dynamometer cards are given which are associated with fluid pound, gas pound, pump friction, tubing slack, well-agitating and flowing, before and after cleaning out paraffin, pumping through the packer, sand passing the plunger, friction in the stuffing-box, and excessive friction in a crooked well, speed change. The checking of the travelling valve, plunger, and standing valve is discussed. G. D. H.

84. The possibilities of secondary recovery by mining in the United States. P. D. Torrey. *Producers' Monthly*, Oct. 1949, **13** (12), 32.—The development of a secondary recovery mining project should be closely related to the cost estimates and the selection of the more efficient systems of production.

The success of mining operations depends on certain conditions: the availability of a high-quality crude the absence of high-pressure gas; continuous sand bodies permeability sufficient to allow gravity drainage; gently dipping beds.

Safety problems, although not insurmountable should be given serious consideration.

The use of such a scheme to the interests of research in the petroleum industry is also mentioned. A. J. H.

85. Secondary recovery equipment selection. J. H. Field and E. N. Kemler. *Producers' Monthly*, Nov. 1949, **14** (1), 15.—The selection and maintenance of efficient equipment is of greater importance in the secondary recovery projects than in the primary development of a field.

The practical considerations in the selection of pumping units, sucker rods, subsurface pumps, and electric motors are presented; data are given in graphical and tabular form. A. J. H.

Oilfield Development

86. World production. Anon. *Oil Gas J.*, 26.1.50, **48** (38), 168.—In Nov. 1949 world oil output was 9,747,800 b.d. Outside the U.S.A. and Russian-controlled areas the figure was 3,696,300 b.d.

A table gives by countries the October and November 1949 and November 1948 outputs. The November 1949 outputs are given for the principal fields of Colombia and Venezuela, while the monthly figures for the Middle East, the western hemisphere without the U.S.A., and the remainder of the world apart from Russia and eastern Europe are given. G. D. H.

87. World production. Anon. *Oil Gas J.*, 23.2.50, **48** (42), 120.—The Venezuelan oil output as estimated for February may be 12% below the January rate. The world total for December 1949 was 9,575,300 b.d., compared with 9,745,700 b.d. in November, and 9,797,600 b.d. in December 1948. The Middle East, Far East, European, and Africa figures for December 1949 were above those for the preceding month, and for December 1948, but the reverse was true for the U.S.A.

A table gives daily outputs by countries for November and December 1949 and for December 1948, while the November and December outputs for Venezuela are given by fields and companies. G. D. H.

88. World production. D. M. Duff. *Oil Gas J.*, 22.6.50, **49** (7), 159.—Exclusive of Russia, Eastern Europe, and the U.S.A., the world output of oil was 3,908,000 b.d. in April; the U.S.A. gave 5,000,000 b.d. Including estimated Soviet-controlled production the world total was nearly 9,770,000 b.d.

Tables give March and April 1950 figures by countries and the April 1949 output, as well as the Venezuelan production by fields. G. D. H.

89. Concerning estimates of potential oil reserves. L. G. Weeks. *Bull. Amer. Ass. Petrol. Geol.*, **34** (10), 1947–54.—The problem of estimating ultimate world oil reserves is notoriously difficult. The writer indicates his belief that a profound study of global oil occurrence is a prerequisite to the preparation of sound estimates of ultimate oil potential, especially if one is to steer clear of false premises in the establishment of "yardsticks" or units of measurement. E. N. T.

90. Foreign production. D. M. Duff. *Oil Gas J.*, 27.4.50, **48** (51), 83.—In February the U.S.A. produced 4,960,000 b.d., and the rest of the world is estimated to have given 4,531,600 b.d. Figures are given for each country and compared with those for January and for February 1949. Figures are given for separate fields in Venezuela, while the monthly trends during the year are shown for the western hemisphere (less the U.S.A.), the Middle East, and the world less the U.S.A. and Russian-controlled areas. G. D. H.

91. Record production. D. M. Duff. *Oil Gas J.*, 25.5.50, **49** (3), 98.—In March oil output outside the U.S.A. and Russian-controlled areas averaged 3,813,000 b.d. This was 17% above March 1949. Venezuela gave 1,386,600 b.d., Iran 706,500 b.d., Saudi Arabia 411,500 b.d., Kuwait 311,600 b.d., Indonesia 120,000 b.d., and Mexico 188,000 b.d. Russian-controlled areas are estimated to have given 855,000 b.d. in March.

Tables give the February and March 1950 daily outputs by countries, and the figures for March 1949 for comparison; the monthly figures for the western hemisphere, Middle East, and the world omitting the U.S.A. and Russian-controlled areas over a year; the Venezuelan production by fields for February and March. G. D. H.

92. No drilling pickup. Anon. *Oil Gas J.*, 27.4.50, **48** (51), 84.—In March 1950, 369 rigs were in operation outside the U.S.A., Russian-controlled areas, Germany, Japan, and Canada. The March 1949 figure was 456. Figures are tabulated by countries. South America had 190 rigs operating, Europe 33, Africa 18, and the Middle East 38. G. D. H.

93. Deep drilling last year cost 100,000,000 dollars. E. Adams. *Petrol. Engr*, Apr. 1950, **22** (4), B-7.—232 deep wells were drilled in the U.S.A. in 1949. Of these, sixty-four found production. Twenty pools were found below 12,000 ft, seven of which were new fields, and the others new sands or extensions of known fields. Deepest completed producer in 1949 was Mushrush 5, in the Wasco field, Kern County, California, which discovered good production of high gravity oil at 15,440–15,530 ft.

Deep-drilling costs in 1949 averaged 432,014 dollars/well, the highest average cost on record.

Tables included give mechanical and production data on wells drilled to 12,000 ft, or below, in the U.S.A. in 1949. C. A. F.

94. International. Anon. *Oil Gas J.*, 15.6.50, **49** (6), 84.—In the week ended May 29 Venezuela had a record output of 1,512,700 b.d., and the May Saudi Arabian production of 550,911 b.d. was also a record.

The Matzen area northeast of Vienna gives about 7000 b.d. Highly productive wells are reported at Gaenserdorf 25 km from Vienna. Oil is said to have been obtained at Aderklaa, which previously gave a little condensate.

In the first quarter of 1950 Mexico produced 16,709,789 brl. G. D. H.

95. Completions again set record. Anon. *World Oil*, Oct. 1950, **131** (5), 50.—4016 wells were completed in the U.S.A. in July 1950, an all-time record. 28,422 wells were completed in the first eight months of 1950 compared with 25,458 in the same period of 1949.

A table shows well completions in the U.S.A. during August 1950, and cumulative for the year, by states or districts. C. A. F.

96. Exploration up 11·9 percent over 1949. Anon. *World Oil*, Oct. 1950, **131** (5), 92.—762 exploratory wells were completed in the U.S.A. in August 1950, compared with 796 in the previous month. 17·7% of these found production. 111 new pays and twenty-four extensions to known fields were found.

Tables show the results of exploratory drilling in the U.S.A. in August 1950 and the first eight months 1950–49, by districts, and the new oil, distillate, and gas fields, and new pay horizons discovered in August 1950. C. A. F.

97. Deeper pays provide more sweet crude in Permian basin. L. J. Logan and C. W. Smith. *World Oil*, Sept. 1950, **131** (4), 60.—In recent years Permian basin production from Lower Permian and pre-Permian, pays which are less sulphurous than Middle or Upper Pennsylvanian pays, has reduced the average sulphur content of crude produced from the basin.

34% of the district's production is from low-sulphur groups, and it is likely that the proportion of " sweet " to " sour " crude will increase with the further development of deep pools in the Lower and pre-Permian. C. A. F.

98. Permian basin dominates U.S. drilling activity. C. W. Smith. *World Oil*, Sept. 1950, **131** (4), 72.—The Permian basin in West Texas and southeastern New Mexico is the most active drilling area in the world. 2665 wells were completed in the basin in the first six months of 1950, 46% more than in the same period of 1949. 722 rigs were operating at the end of June 1950, 15·2% of all rigs operating in the U.S.A. C. A. F.

99. Tex-Harvey field opens large new producing zone. Anon. *World Oil*, Sept. 1950, **131** (4), 93.—The Tex-Harvey field was discovered in March 1949 and is producing from the Lower Permian Spraberry sand, topped at about 7000 ft. Pay thickness is over 300 ft, divided by a shale band.

It is expected that over 15,000 acres will be productive with yields of 10,000–20,000 brl/acre. Twelve wells have been completed on 40-acre spacing, with an average potential of 250 b.d/well of 40·2° oil. Some of the wells are flowing.

The discovery well, B. W. Floyd 1–16, also found oil in the Pennsylvanian and had shows of oil and gas in the Devonian.

Drilling and completion practice is described. C. A. F.

100. Completions at all-time peak rate. Anon. *World Oil*, Aug. 1950, **131** (3), 55.—20,353 new wells were completed in the U.S.A. in the first six months of 1950, compared with 18,757 during the same period of 1949. It is estimated that a record number of at least 43,000 wells will have been drilled by the end of this year.

A table shows well completions in the U.S.A. during June 1950, and cumulative for the year, by states or districts. C. A. F.

101. Arkansas has five oil pools, two gas pools in 1949. Anon. *Petrol. Engr*, Apr. 1950, **22** (4), B-94.—Five new oil pools and two gas pools were discovered in Arkansas in 1949.

The oil discoveries were in Columbia, Union, and Ouachita Counties. Pays were: Jurassic Smackover in three of the pools, and Travis Peak and Trinity.

Gas was discovered in Franklin and Crawford Counties. C. A. F.

102. Elk Hills production runs 8000 bbl a day. Anon. *Petrol. Engr*, Sept. 1950, **22** (10), B-82.—In the Elk Hills field, California, eighty-eight wells in the Stevens zone, and 570 in the Shallow zone are available for production. Current production averages 8000 b.d., but the field's potential is 80,000 b.d. C. A. F.

103. Two Colorado extensions. Anon. *Petrol. Engr*, Sept. 1950, **22** (10), B-86. At the Fort Nigera field, southeastern Colorado, extension wells on test flowed 25 brl/hr and 2,500,000 cu. ft. gas/day from the Muddy Sand. The discovery well of the field is pumping 20–52 brl/hr.

In the Merimo field, also in northeastern Colorado, a westerly extension well has tested the Dakota.

Both fields are in the Denver Basin. C. A. F.

104. 112 wells drilled below 12,000 ft in Gulf Coast area in 1949. L. D. Owen. *Oil Gas J.*, 22.6.50, **49** (7), 244.—In 1949 six wells in the Gulf Coast area were drilled to 15,000–16,000 ft, twelve to 14,000–15,000 ft, thirty-one to 13,000–14,000 ft, and sixty-

three to 12,000–13,000 ft. The Lake Raccourci field was opened with gas-condensate production at 14,434 ft, a record depth. 296 of the 514 U.S. wells drilled below 12,000 ft are in Louisiana; there are ninety-one in Texas, fourteen in Mississippi, nine in Florida, and four in Alabama. Twenty-three fields have production below 12,000 ft, twenty being in Louisiana, two in Texas, and one in Mississippi.

Tables give by years the numbers of wells drilled to various depths below 12,000 ft, a list of the Gulf Coast wells drilled below 13,500 ft, the numbers of 12,000-ft wells drilled by states, and the location of producers completed below 12,000 ft. G. D. H.

105. Oil and gas developments in Louisiana. L. W. Hough and A. C. Chauviere. *Petrol. Tech.*, June 1950, **2** (6), 31–58.—In 1949 Louisiana produced 184,450,829 brl of oil, 13,426,300 brl of condensate, and 1,025,474,930 cu. ft. of gas. 2920 wells were active, 335 being wildcats. Eight wildcats were successful in North Louisiana and thirty-four in South Louisiana. 358 geophysical permits were issued and 272 were renewed (138 permits were issued in the Gulf of Mexico and 359 were renewed).

Notes are given on the 1949 discoveries, thirteen of which lay in the Gulf of Mexico.

Tables compare 1948 and 1949 production, enumerate gravity and seismic permits and renewals by parishes in the same two years, list the 1949 discoveries with salient data, tabulate the fields with production, drilling and geological data, and summarize 1949 drilling results by parishes. G. D. H.

106. Oil and gas developments in Ohio during 1949. R. L. Alkyrie. *Petrol. Tech.*, June 1950, **2** (6), 59–64.—In 1949 1052 wells were drilled in Ohio in search of oil and gas. 626 were successful. The initial average oil output was 28 b.d., and the gas output averaged 676 M.c.f/day. The 1949 output was 3,484,936 brl, and reserve extensions and revisions totalled 2,646,000 brl. At the end of 1949 gas reserves were 585,597,000 M.c.f. 40% of the wells sought Clinton production and 31% Berea.

A well found a little oil and gas in the St Peter.

Forty-one exploratory wells were drilled, eight finding gas and four oil. A map shows the oil and gas fields, tables give the geological sequence, summarize the 1949 drilling results by counties and formations, compare drilling results yearly from 1944, and give oil and gas outputs over the same period. G. D. H.

107. West Texas. J. C. Watson. *Oil Gas J.*, 27.4.50, **48** (51), 132.—Westbrook was West Texas' first commercial producer; Big Lake followed in 1923. Output rose from 1,348,299 brl in 1924 to 125,672,000 brl in 1929. This period embraced the discovery of Todd, Yates, Hendrick, Hermit, Penwell, Scarborough, North Wards-Estes, McElroy, Crane-Cowden, etc. Production fell to 48,126,000 brl in 1934. There was a further peak of 117,570,000 brl in 1941, a drop to 31,030,000 brl in 1942 because of war conditions, and then a rise to 288,146,000 brl in 1949.

At the end of 1949 proven reserves were estimated at 5,238,000,000 brl. In 1943, 902 wells were drilled in West Texas, and 3261 wells in 1949. The latter figure included 343 wildcats, of which sixty-three found oil and six found gas.

Before 1942 there had been little drilling below the San Andres water level, although Simpson and Ellenburger production was known. Beginning in 1942 a number of Clear Fork discoveries were made; in 1943 prolific production was found in the Ellenburger at Keystone. These oils were sweet and light. Devonian production was found at Crossett in 1944. In 1946 Pennsylvanian reef production was obtained at Jameson on the east side of the Permian basin. The Pegasus discovery has stimulated interest in the deep possibilities of the Midland basin and led to a Mississippian discovery in southeast Gaines County. 1948 saw the Scurry County finds.

At the beginning of 1950 West Texas had 25,872 producing wells. Present allowables are a little over 50% of the outputs possible at the max efficient rate. At the beginning of 1950 there were 356 oilfields. G. D. H.

108. Alaskan oil search to be accelerated. Anon. *World Oil*, Oct. 1950, **131** (5), 228.—Two wells have been completed this year in the U.S. Naval Petroleum Reserve No. 4, and four are drilling. Most wells drilled in the area have had shows of oil and gas, but no commercial production has been found. Wells drilled recently have been sited on surface or seismic evidence. The north, central, and eastern sections of the

Reserve are being drilled. Exact locations of the areas under development are kept secret for security reasons.

Supplies and personnel are flown from Fairbanks to the camp at Pt Barrow on the north coast.

A map showing the areas of activity of the Naval Reserve is included. C. A. F.

109. Canada : reserves aplenty. C. J. Deegan. *Oil Gas J.*, 25.5.50, **48** (3), 91.—For the same group of gas fields in Alberta reserve estimates prepared for Westcoast Transmission Co. Ltd. and the Alberta government were, respectively, 3,650,000 and 4,261,700 million cu. ft. calculated to 100 p.s.i.a. abandonment. The Westcoast company also had reserves of 5,947,000 million cu. ft. in other Alberta fields. For transmission of gas to the west coast there is argument about an all-Canadian route to Vancouver with a branch south to the U.S.A. and a more southerly route to Spokane in Washington and a northerly branch to Vancouver. The former is most strongly favoured. A pipeline east to the Winnipeg area is also proposed. The reserve requirements of this line are rather modest. The Alberta authorities demand that in so far as is practicable residue gas from oilfields shall be taken to avoid waste.

It has been suggested that the Alberta gas reserves shall be allocated as follows : Alberta gas companies 2784×10^9 cu. ft. (fifty years' supply), eastern line 650×10^9 cu. ft. (twenty-six years' supply) and Westcoast 1869×10^9 cu. ft. (thirty years' supply).

A table gives a tentative allocation of the fields. G. D. H.

110. Economic and other aspects of recent petroleum and natural gas discoveries in Western Canada. J. O. Galloway. *Canad. Min. metall. Bull.*, Sept. 1950 (461), 495–9.—Until the discoveries of considerable oil reserves in the western states in recent years, Canada depended entirely on outside supplies from dollar areas to augment her small output. Current production from Western Canada exceeds the local demand, and plans are being made to supply part of the needs of eastern Canada and British Columbia from the new fields, and thus reduce imports and ease the " dollar shortage."

Oil reserves in Alberta are approx 1 billion brl, and proved gas reserves as at Feb. 1949, were 4·26 trillion cu. ft. In the first half of 1949, oil production in Western Canada reached 60,000 b.d., and wells in highly productive areas were cut back. Exploration is continuing rapidly, and there have been several important new discoveries. Stettler is likely to be a major field. Active exploration is in progress in Saskatchewan and, to a lesser extent, in Manitoba and British Columbia. A wildcat is being drilled on a seismic feature in southwestern Manitoba.

A pipeline is to be built from Edmonton, Alberta, to Superior, Wisconsin, which will help to solve transport and refining problems. The max capacities of refineries in the prairie provinces is about 80,000 b.d., which is insufficient to meet current potential production of 100,000 to 125,000 b.d.

Canadian imports are approx 200,000 b.d., costing over 200 million dollars annually.

Three maps showing the western Canadian fields, refineries, and pipelines are included. C. A. F.

111. Increased production in Chile speeds refinery construction. Anon. *World Oil*, Aug. 1950, **131** (3), 248.—Thirty-one wells have been drilled in Chile's Spring Hill field (Cerro Manantiales), and one is drilling on the northeast flank of the structure. Pay is at about 7500 ft.

Present field production is 2000 b.d., and plans are being made to increase this to 10,000 b.d. by 1955.

An 8-in pipeline connects the field to the terminal at Caleta Clarencia on Gente Grande Bay. A refinery is to be built having a throughput of approx 12,000 b.d. with limited cracking facilities. C. A. F.

112. Venezuelan crude production rate continues to increase. Anon. *World Oil*, Aug. 1950, **131** (3), 252.—Venezuelan production is increasing. Daily production averaged 1,586,866 brl for week ending June 26, 1950.

P-108, north of the La Paz field, was completed in June 1950 for 6500 b.d.

VL-2, on Lake Maracaibo, was abandoned at 7125 ft, and Zulia 34D-1, 39 miles southwest of Maracaibo, was also abandoned at 13,400 ft. C. A. F.

113. Present production in Lacq. R. Oleves. *Rev. Inst. franç. Pétrole*, July 1950, 5 (7), 224–6.—Wells No. 1 and No. 3 are pumpers and yield relatively small amounts of oil with water, while No. 2 and No. 4 flow dry oil. In December 1949 No. 1 reached 696 m after penetrating 60 m of impregnated limestone and indicated the proximity of water. Three D.S.T.s indicated a potential of about 50 m^3/day of oil. The max test rate was 30 m^3/day, and the productivity index was 0·65 m^3/day/kg/cm^2 differential. A pump was installed and the output was 10 m^3/day. Water appeared when the production totalled 300 m^3, and now is steady at 16%. The salinity is 4·7 gm/litre. This may be bottom or top water.

No. 2 is 500 m west of No. 1. All circulation was lost at 617·5 m. After testing, the bottom-hole pressure was found to be 61·3 kg/cm^2 at 620 m. By June 24, 1950, the well had given 7150 m^3 of oil, while No. 4 had given 2770 m^3. The pressure is the same as in No. 2, and No. 4 also had a loss of returns which were returned in the production.

The oil is asphaltic, with 3·89% of sulphur and a density of 0·925. The gas has 21·8% of propane and 23·4% of butane and *iso*butane, 1·01% of H_2S and 4% of nitrogen.

The handling of the production is briefly described. It is inferred that the field is under water drive. G. D. H.

114. Germany's oil occupies vital position in Western Europe. Anon. *World Oil*, Oct. 1950, **131** (5), 240.—Current oil production in Western Germany is about 6 million brl. Seven new fields were discovered in 1949, including the Eldingen field, 11 miles northeast of Celle, and the Suderbruch field, both believed to be faulted anticlines. The second well drilled near Quakenbrueck, between Hanover and the Emsland fields on the Dutch border, flowed 284 b.d. from Lower Wealden at 1900 ft. Oil is high paraffin base.

Drilling 1½ miles offshore from Cuxhaven was begun in May 1950. A well is being drilled near the mouth of the Elbe, and further wells are planned, 1½–3 miles from the shore. The derrick floor is 23 ft above low water level, and personnel and materials are conveyed by launch.

1950 output from Western Germany is estimated at over 7 million brl. C. A. F.

115. Western Germany produces shale oil from Messel mine. Anon. *World Oil*, Aug. 1950, **131** (3), 244.—Western Germany has a small supply of oil from the Messel shale mine, a few miles northeast of Darmstadt, between Frankfurt and Heidelberg. 136,800 brl oil were processed in 1949.

The deposit occupies about 200 acres and is basin-shaped, with max thickness of 600 ft at its centre. Oil content of the shale is 5–11%, and estimated reserves are about 216 million brl.

Mining is by open-cut methods. Shale received at the plant contains about 40% water and 35% ash. Daily shale output is about 960 tons. Hydrocarbon output is about 347 brl of heavy paraffin oil, 33 brl condensate, and 30 brl naphtha.

Shale residues remaining after the oil extraction are converted to building bricks. C. A. F.

116. Two Balkan countries attempt to increase oil production. Anon. *World Oil*, Aug. 1950, **131** (3), 252.—Albanian production for the first half of 1950 was reported as 990,000 brl, of which 70% was produced from the Devoli field. Development of the Berat and Skodra Lake fields has been slow due to lack of drilling equipment.

It is reported that oil has been found along the Albanian–Greek border, northeast of Santi Quaranta Beach. The area is not to be developed at present.

Yugoslavia produced 646,800 brl in the first six months of 1950. The government is to purchase drilling equipment to explore the Albanian border in central Bosnia and in Ucinj, Dalmatia. C. A. F.

117. Egyptian well discovered. Anon. *Petrol. Engr*, Sept. 1950, **22** (10), B-84.—A well recently completed in the Hurghada field on a two-week test averaged 250 b.d. The field, discovered thirty-seven years ago, has forty-three pumping wells averaging 23 b.d/well. C. A. F.

118. Pakistan opens to American oil men. Anon. *World Oil*, Aug. 1950, **131** (3), 238.—Technical help from U.S. operators is to be sought by Pakistan to develop the country's oil reserves in the Pantharias Forest area, East Bengal.

Oil was first discovered in Pakistan in the last century, when seeps were noted at Khattan in Baluchistan and elsewhere. Several wells were drilled, producing about 20,000 brl. Four oilfields were subsequently discovered in the Potwar region of West Punjab.

Oil was discovered in the Pantharias Forest area in 1933, and the discovery well had an estimated potential of 10,000 b.d. The field was not developed. A second well drilled in the Chakwal area in West Punjab found oil at 8214 ft in 1949.

Lower Tertiary domes are to be tested at Kohistan (Sind), the Marri and Bogti country, Khaur Dhulia, and Joya Mair. C. A. F.

Transport and Storage

119. Gas industry to spend $3·14 billions for new line construction. Anon. *Pipe Line News*, Aug. 1950, **22** (8), 10.—A summary, including tabulated expenditure for the period 1950–54, is based upon the American Gas Association report of new and expanded facilities planned by the gas-utility industry. 51% of the anticipated expenditure of $3140 million is to be spent on new transmission lines. F. M.

120. Products pipe line system, an economic study. R. H. Lynch. *Pipe Line News*, Oct. 1950, **22** (9), 25–8.—The calculation of cost and return for a projected products pipeline is outlined. Calculation of number of pumping-stations required for a given throughput over a given territory with various diameter lines is illustrated graphically. F. M.

121. Southern Natural $33 million, 807 mile gas line project approved. Anon. *Pipe Line News*, June 1950, **22** (6), 13–14.—Details are given of the Southern Natural Gas Co. expansion programme approved by Federal Power Commission in May. The main line will extend from Gwinville, Miss., gas field to Aiken, South Carolina. Delivery capacity will be raised from 420 million to 529 million ft/day. Additions to the existing facilities and details of new facilities to be constructed are listed. F. M.

122. The Texas Gas Transmission Corp. Story. Anon. *Pipe Line News*, June 1950, **22** (6), 16–25.—The Texas Gas Transmission Corp new 800-mile line was completed in February, and deliveries of 235 million cu. ft. of gas/day are anticipated. The line includes 723 miles of 26-inch line from the Lisbon gas field in Louisiana to a point near Middletown, Ohio, and 110 miles of 20-inch line from the Carthage field in East Texas to the Lisbon field. Details of the six river crossings encountered are given, with brief notes on the terrain encountered, and on the soil conservation and area development programmes. Details of six compression stations installed on the 26-inch line are included. F. M.

123. Texas–Illinois 1,331 mile gas line approved. Anon. *Pipe Line News*, July 1950, **22** (7), 16.—The F.P.C. have authorized the Texas Illinois Natural Gas Pipeline Co., to proceed with the projected 1331 line from La Gloria, Old Ocean, and Chocolate Bayou Fields in Texas to a termini near Joliot and Volo, Illinois. Details of the facilities approved by F.P.C. are given. F. M.

124. Waskom–Perla line in operation. Anon. *Pipe Line News*, Sept. 1950, **22** (9), 23.—The Arkansas–Louisiana Gas Co. 20-inch pipeline from the Waskom area of Harrison County, Texas, to Perla, Arkansas, has been completed. Difficulties encountered are described, and the crossing of Red River near Shreveport is illustrated. F. M.

125. Short cut from West Texas. Anon. *Pipe Line News*, Aug. 1950, **22** (8), 11–14. —An account is given of the laying of a 370-mile 18-inch pipeline from Kemper, near Big Lake, to Salsuma, near Houston. The line cuts 52 miles off the previous route, and

with three pumping-stations it can deliver 135,000 b.d. of oil, nearly three times as much as the old system. F. M.

126. Tennessee gas nearing completion of 1950 $100 million expansion. Anon. *Pipe Line News*, Oct. 1950, **22** (10), 14–18.—An illustrated account of the 295 mile 26-inch extension pipeline from North-eastern Kentucky to near Buffalo of the Tennessee Gas Transmission Co. main service from Texas. Brief details are given of other items in the company's 1950 expansion programme now nearing completion. F. M.

127. Teamwork in pipe line construction. Anon. *Pipe Line News*, Oct. 1950, **22** (9), 18–21.—An account of the co-ordinated team work required in the laying of 8000 ft daily of 16-inch pipe across Eastern Tennessee on a section of the East Tennessee Natural Gas Co. Corp. loop. Details are given of equipment used, and various operations are illustrated. F. M.

128. Plantation pipe line expansion programme. Anon. *Pipe Line News*, Oct. 1950, **22** (10), 12.—A description, with map, is given of the new lines to be laid in the Plantation Pipe Line Co.'s expansion programme to loop its system with larger-size lines. Total expenditure is estimated at $52 million, of which pipeline construction will absorb $20½ million. The new pipeline extends from Baton Rouge to Greensboro, N. Carolina. F. M.

129. Million dollar crossing. W. C. Kinsolving. *Pipe Line News*, June 1950, **22** (6), 26–9.—The Mid-Valley pipeline of the Standard Oil Co. of Ohio from Longview, Texas, to Lima, Ohio, crosses the Mississippi River at Mayersville. A double line, one bowed up-stream the other bowed down-stream, was layed in a dredged channel, the pipe being coated with ⅜-inch Somastic coating followed by a 2-inch reinforced-concrete jacket precast over the entire length of the pipe. Details of the dredging and laying operations are given. F. M.

130. Mechanical vibration of piping induced by gas pressure pulsations. R. C. Baird and I. C. Bechtold. *Pipe Line News*, July 1950, **22** (7), 21–4.—The generation and nature of gas pipeline pressure pulsations are described, and the mechanism is discussed by which such pulsations produce mechanical vibration in pipes and associated structures. The analogy between mechanical, electrical, and acoustical flow systems is used to illustrate the properties of vibrational systems. The mechanism by which pulsations are propagated through a pipeline is discussed with particular reference to petroleum industry structures. F. M.

131. Lowering in procedure incorporating the slack loop practice. T. B. La Rock. *Pipe Line News*, July 1950, **22** (7), 25–7.—The procedure adopted by the El Paso Natural Gas Co. for lowering in pipelines incorporating slack loops is described, with details of the calculations and operations involved in the laying of a new 30-inch transmission line. F. M.

132. Hudson River crossing. G. H. Landis. *Pipe Line News*, Aug. 1950, **22** (8), 18–20.—Details are given of the laying of two 2600-ft 8-inch pipes across the Hudson River between Poughkeepsie and Highland. F. M.

133. Design of an unattended automatic booster station. J. P. Hedlin. *Oil Gas J.*, 19.10.50, **49** (24), 86.—The Standard Oil Co. has an unattended automatic booster station on the Wyco Pipe Line Co. products line from Casper, Wyo., to Denver, believed to be the first in the industry.

As station is unattended, heating plant, water well, and other facilities are eliminated. The station is a two-unit 250-h.p. station, capacity 18,500 b.d. of 0·730 gravity gasoline at a pressure of 215 p.s.i. per unit or a total of 430 p.s.i. for both units.

Safety features include a delay timer which will shut down the unit if the motor-operated valve does not reach its full-open position in 75 sec. G. A. C.

133a. Remotely controlled pipe-line stations. S. S. Smith. *Oil Gas J.*, 26.10.50, **49** (25), 82; *Pipe Line News*, Oct. 1950, **22** (9), 22–4.—The operation of automatically-

controlled pipeline stations, including secondary control apparatus, control of basic station, mechanical seals, selector circuits, and one-minute shut-downs are dealt with.

A schematic diagram of teletype-controlled electric station, and one of a pipeline-station-control system are given. (See also Abstract No. 314, 1950.) G. A. C.

134. Shell develops new fully automatic. Anon. *Pipe Line News*, Aug. 1950, **22** (8), 21.—An account is given of the opening of the new Shell automatic-controlled pumping-stations on the products pipeline between Wood River and Columbo Ohio. Control is by teletype signals operated in New York. The line is equipped to carry up to twenty-two different products pumped through the line one after another, the progress of the flow being recorded automatically in the Control Office. F. M.

136. "Steep inch" Venezuelan oil pipe line has 3000 ft elevation. Anon. *Pipe Line News*, Sept. 1950, **22** (9), 20–1.—A brief account is given of the Tacagua oil-products line built for Creole Petroleum Corp and Shell-Caribbean to supply Caracas with 250,000 g.p.d. of refined petroleum products. The new 8¾-inch line starts at Catia La Mer pumping-station 60 ft above sea-level, crosses the Sierra del Avila at 2300 ft, descends into the Tacaqua Valley about 1000 ft above sea-level, and finally climbs to 3100 ft above sea-level at Caracas. At points in this final climb the grades are as steep as 45%. F. M.

137. Graphs can avert trial-and-error in many fluid flow computations. M. Nord. *Chem. Engng*, 1950, **57** (8), 112–15.—The basic Fanning friction factor equations are manipulated for four different cases to bring the unknown variables to one side. Graphs based on these are presented with ordinates of known variables and the abcissa being Reynolds' number times a parameter, from which the unknown variable can be calculated directly. D. H.

138. Storage and transportation of crude oil and its derivatives. R. Bittmar. *Nafta*, July–Aug. 1949, **5**, 195–9.—A review of Polish safety legislation in the light of experience. M. S.

139. Instruments for pipeline pressure-surge studies. F. O. Stivers. *Oil Gas J.*, 12.10.50, **49** (23), 116.—Instruments available for hydraulic pressure surges in oil lines and pump-station piping are assessed.

Instruments usually employed for measuring transient pressures consist of a transmitter which converts a pressure change into some measurable electrical variable, with a receiver which accepts the transmitted signal and produces a written record. Sensitivity and stability of pick-up device are essential.

Two types of pick-up devices are used by Humble Pipe Line Co., interchangeably with one recording unit. A diaphragm strain gauge and battery-supplied Wheatstone bridge make up the transmitting unit employed for some problems, unbalance of the bridge producing a change in potential; but where frequency analyses are to be studied the electrokinetic pick-up, which utilizes the phenomenon of the streaming potential of a liquid through a porous solid, is used.

Transducers of the strain gauge and condenser type are not as sensitive and require more auxiliary equipment than self-generating pick-ups like crystal-type, electromagnetic, and electrokinetic instruments.

Three figures illustrate the article. G. A. C.

140. Gaskets for the oil industry. H. H. Dunkle. *Oil Gas J.*, 5.10.50, **49** (21), 194.—Various gaskets and their uses are described, including compressed asbestos sheet-packing, corrugated metal, corrugated metal-jacketed asbestos, spirally wound metal-asbestos, flat metal-jacketed asbestos, and ring-type joint gaskets.

Some simple handling rules include protection of flange faces until final assembly, cleaning of unprotected flange faces, protection of gasket from damage until installed, correct centring, and uniform application of bolt stresses in proper sequence. G. A. C.

141. Patent. C. E. Starr and F. T. Ratliff, assrs to Standard Oil Development Co., U.S.P. 2,509,891, 30.5.50. Method of stabilizing xylidene against discoloration during storage, by adding 0·01–0·5% by wt of a mono*cyclo*hexylamine. C.F. S.

Refinery Operations

Refineries and Auxiliary Refinery Plant

142. Some aspects of plant maintenance. M. H. Wiegandt. *Mech. World*, 6.10.50, **128** (3325), 319.—Trouble-free machinery can make an important contribution to productive capacity, and for this reason good maintenance is essential in an efficient organization. Wear is the main problem, and improvements in performance can often be obtained by using special wear-resistant steels and alloys. Although initially more expensive, these materials pay for their use in the long run. Maintenance can be aided by suitable design features so that the drawing-board stage is the time when machinery maintenance should receive detailed attention. The main features of good maintenance are regular cleaning and lubricating service, with fixed intervals for general inspection. Apart from the neglect of these factors, the commonest cause of trouble is the overloading of bearings by distortion, misalignment, or bad fitting. Soluble-oil emulsions in gear-boxes or feedboxes should be avoided as much as possible by regular draining of the boxes. Sign and colour schemes are useful for lubrication, the signs to indicate frequency of lubrication and the colours to indicate the grade of oil to be used. Experience shows that 2·5–5% of the total number of employees is an adequate figure for the size of the maintenance-personnel staff. A. S.

143. Unit processes.—(Third Annual Review.) *Industr. Engng Chem.*, 1950, **42** (9), 1639–768.—Kinetics review includes reference to Friedel–Crafts reaction and fluidized cat cracking. Equilibria of hydrocarbon synthesis, hydrocarbon processing, synthesis gas production, aromatization of gasolines, etc., and hydrogenation are mentioned.

Alkylation is classified according to the method of bonding, *e.g.*, to O_2, N_2, C, S, Si, or metal. Alkylating agents are listed. The review of hydrogenation includes sections on hydrogenation of aliphatic unsaturation, and saturation of aromatics (for intermediate cat cracking).

Isomerization includes reference to the platforming process, the isomerization of naphtha fractions for octane improvement and desulphurization, and the Oxo process. Oxidation of natural gas, of synthesis gas (using steam and CO_2), and of aromatic hydrocarbons for phenol is mentioned. Oxidation theory is reviewed. Pyrolysis of coal and shale is reported, with sections on theoretical aspects, raw materials high- and low-temp carbonization, products, and coke properties. Thermal cracking is reviewed. Theoretical principles and practical inovations are described. Catalytic cracking, reforming and dehydrogenation, chemical concepts, and industrial features are reported. A collective review of minor unit processes includes sections on desulphurization of fuel gases (wet and dry) and of petroleum materials. Extensive bibliography is appended to each review. R. G. T.

144. Process monitoring systems. E. J. Grace. *Oil Gas J.*, 5.10.50, **49** (22), 202.—Most of the systems described are in operation at the Toledo refinery of the Sun Oil Co., and include a dialling system for 1000 points using a feed-back indicator, a scanning system for 1000 points using an indicator with alarm, a continuous indicating system using one measuring device for 20 indicated points, a survey system that permits recording any combination of 10–100 points using a dial for selection, a control-point setting system that will permit remote setting of 1000 controllers with one master unit, and remote operation of electric motors, valves, etc, using a single push-button station or controller. G. A. C.

145. Eagle Point furfural unit operates on middle distillates. Anon. *World Petrol.*, 1950, **21** (8), 57–9.—Furfural plant is described for the production of high-grade burning and diesel oils (cetane No. 50+, S reduced 75–90%). Cracking value of cycle stock is improved, 25% less coking occurs, and naphtha and butane yields are increased. Extract is used to improve fluidity of other fuels. The unit (design 8200 b.s.d.) had processed as much as 13,200 b.s.d. of cycle stock. Solvent ratio (25%) and temp (70°–125° F) are lower for cat gas oil than in lub.-oil treatment. Solvent recovery is of greater importance than in lub.-oil treatment, and losses are $<0{\cdot}01\%$ on charge.

Inhibitor is used to prevent oxidn of furfural, or alternatively the stock is degassed to prevent air entering the system. E. B.

146. French refineries equipped to meet national needs. H. M. Ballande. *World Petrol.*, 1950, **21** (8), 62–5.—Indigenous production and importation of crude oil discussed against financial background. Refinery expansions are described. Data on amounts of crude imported and output of individual products are tabulated. E. B.

147. Caltex refinery at Rotterdam exemplifies most modern features of construction. H. B. Nichols. *World Petrol.*, 1950, **21** (8), 66–8.—Completely new refinery has been erected to process 20,000 b.d. of Arabian crude. Plants include 22,500 b.d. 2-stage atm-vac dist unit to give gasoline, kerosine, light, medium, and heavy diesel fuel, heavy waxy gas oil, and 9% residuum. The last cut is charged to a U.O.P. two-coil thermal cracker designed for 7500 b.s.d. of 20/25° A.P.I. waxy gas oil charge. A U.O.P. thermal reformer will process up to 7000 b.s.d. of heavy S.R. naphtha. Other units include polymerization (H_3PO_4 cat) and Edeleanu for kerosine. E. B.

148. Pick off economic insulation thickness. R. A. Bayard. *Chem. Engng*, 1950, **57** (6), 142–4.—A family of graphs enabling the economical insulation thickness to be determined is presented, and four numerical examples given.

It is based on the equation

$$PYT(L_1 - L_2) = C\Delta t$$

where P = cost of heat in mils per kW/hr, or in multiples of 29 c per million B.Th.U.
Y = life of insulation in years.
T = hr of use per year divided by 8760.
L = value of heat lost in cents per sq. ft. per yr for heat costing 1 mil per kW/hr or 29 c per million B.Th.U.
C = cost of insulation in cents per board foot in place.
t = thickness of insulation in inches.

D. H.

149. Performance of vapour-lift pump under vacuum. N. R. Mukherjee and H. R. C. Pratt. *Industr. Engng Chem.*, 1950, **42** (9), 1883–94.—Operation of a vapour-lift pump of 1-inch nominal bore has been studied between pressures of 2- and 10-inches Hg absolute using dipentene as a test liquid. Rate of lift increases with relative submergence and possibly with net height lifted, but shows a max value as pressure is increased. Authors explain the latter phenomenon by the rapid increase in the energy loss due to friction. Inlet liquid temp also shows a critical optimum value, being lower than the sat temp corresponding to the pressure in the system. Correlation of overall H.T.C. in the heating zone showed that H.T.C. $\propto$ (liquid velocity)$^{0.8}$. Experimental coeff were found to be 3 $\times$ coeff calc from forced-convection principles. This difference is attributed to incipient vaporization in the liquid film caused by the pulsating pressure variations. With constant steam pressure and inlet liquid temp, increasing pressure increased the rates of lift and H.T.C.s. Control of rate of lift is best performed by controlling liquid inlet rather than steam pressure. R. G. T.

150. Falling-film high vacuum still. L. U. Spence. *Industr. Engn. Chem.*, 1950, **42** (9), 1926–9. (*Divn Industr. Engng Chem., 117th Mtng, Amer. Chem. Soc., Houston, Texas.*)—A pilot-scale high-vac falling-film still used for distillation of high b.p. esters is described. Evaporating surface 12·75 in $\times$ 18 in is heated by Dowtherm. The condenser is a water-cooled concentric cylinder i.d. 16 in. Rates of 50–60 lb/hr/sq. ft. at 0·3–0·4 pressure were obtained for di-2-ethylhexyl sebacate. Increase from the present size of 260 lb/hr to 2000 lb/hr is suggested as practical. R. G. T.

151. Remote condenser falling-film high vacuum still. F. C. Benner and A. Dinardo. *Industr. Engng Chem.*, 1950, **42** (9), 1930–4. (*Divn Industr. Engng Chem. 117th Mtng Amer. Chem. Soc., Houston, Texas.*)—The pilot-scale falling-film type still here described operates at high vacuum and shows high evaporation rate, compact equipment size, and high production rates, with consequent min operating costs. Operation of the

still on a charge of plasticizer-type ester (*e.g.*, di-2-ethylhexyl sebacate) is reported. A flow diagram is included. R. G. T.

152. Valves for the chemical industry. J. H. Timmer. *Ingenieur*, **62** (31), Ch. 53.—An analysis of the effect of chemical service conditions on valves in general, which points out the difference in working conditions between valves in chemical service and those handling neutral fluids such as water, steam, and compressed air.

The dictates of chemical service on the selection of materials and the design of the valve are examined, and the difficulties in fabricating from the most resistant materials are also referred to.

Protection is discussed, by a resistant lining of some other material—either metallic or non-metallic—of materials which are in themselves unsuitable, and the article closes with a reference to some types of diaphragm valves, together with a brief indication of their practical limitations. Four drawings of valves in section are included. R. R.

Distillation

153. Plates vs. vapour rates—by a quick simple method. J. W. Donnell and C. M. Cooper. *Chem. Engng*, 1950, **57** (6), 121–4.—Using the Fenske equation for min plates and the Underwood method for min reflux ratio, a correlation curve gives quickly and simply the number of theoretical plates required for any vapour rate.

The equation holds where the ratio of key components in the feed is between 5 and 0·2, and where relative volatility is between 1·25 and 10. Deviation outside these limits is less than 20% for all systems covered, and a method of covering these extremes is outlined. D. H.

154. Hold up in batch distillation—critical reflux ratio. A Rose, T. J. Williams, and C. Prevost. *Industr. Engng Chem.*, 1950, **42** (9), 1876–8. (*Divn Industr. Engng Chem. 116th Mtng Amer. Chem. Soc., Atlantic City, N.J.*)—The relation between hold-up, charge, and sharpness of separation in batch distillations has been studied. The effect of hold-up, charge ratio, on sharpness of separation depended mainly on the reflux ratio. A critical reflux ratio was found at which hold-up had no effect on separation. Below this critical value increased hold-up was beneficial. Above the critical value the effect of increased hold-up became increasingly detrimental to the sharpness of separation. R. G. T.

155. Research on packed columns operating under reduced pressure. Anon. *Ingenieur*, **62** (31), Ch 57.—Work carried out on liquid–vapour equilibria of the system *n*-decane–*trans*decaline over a pressure range of 10–760 mm Hg is referred to, and its suitability for application to research on distillation columns operating under reduced pressures is pointed out. Three graphs are included in the article, showing (1) correlation of equilibrium data of the system *n*-decane–*trans*decaline, (2) separation as a function of liquid loading for different packings, and (3) pressure loss as a function of liquid loading. R. R.

156. Patents. J. A. Patterson, assr to Standard Oil Development Co., U.S.P. 2,509,044, 23.5.50. Separation of low mol.wt. hydrocarbons from petroleum mixtures.

S. W. Wilson, assr to Standard Oil Development Co., U.S.P. 2,510,847, 6.6.50. The improvement in the distillation of polymerizable diolefins, which comprises fractionally distilling in the presence of a polymerization inhibitor consisting of a mixture of an amine of a bi-nuclear aromatic and a hydroxy bi-nuclear aromatic hydrocarbon.

Absorption and Adsorption

157. The density of water sorbed on charcoal. H. L. McDermot and N. G. M. Kuch. *Canad. J. Res.*, 1950, **28B**, 291.—An apparatus, which eliminated the carry-over of water vapour to the sorption cell, was used to measure the apparent vol of water sorbed by a zinc chloride-activated charcoal over the entire range of relative pressures. The vol was always greater over the entire sorption isotherms than normal vol of equal wt

liquid water, and was higher on desorption than adsorption. Agreement was expressed with Wiig and Tuhola, but not with Morrison and McIntosh. A. D.

158. Patent. J. D. Danforth, assr to Universal Oil Products Co., U.S.P. 2,509,486, 30.5.50. Process for the separation of hydrocarbons by passing a mixture upwardly through a bed of adsorbent silica, and afterwards passing into the adsorbent bed a desorbing liquid to displace the hydrocarbons. C. F. S.

Cracking

159. Double-duty catalyst. G. Weber. *Oil Gas J.*, 19.10.50, **49** (24), 78.—The dual use is described of natural-clay catalyst for both lubricating-oil treating and subsequent fluid catalytic cracking at two eastern plants of Sinclair Refining Co.

After conventional use in the contact treaters which are operated in conjunction with nitrobenzene and M.E.K.–benzol solvent refining lubricating oil units, the washed and dried spent clay is transported some 250 miles in covered hopper cars.

The spent catalyst, on arrival, is slurried under safety conditions and pumped to the reactors at the rate of 2·4 tons/hr. The method has been in use eighteen months, and has proved entirely practical and economical. G. A. C.

160. Carbide and acetylene. Anon. *Chem. Engng*, 1950, **57** (6), 129–36.—In a comparison with other methods, the production of acetylene by cracking of natural-gas or coal-hydrogenation by-product gases is outlined.

The Hüls arc process requires 10–14 kWhr/kg of acetylene. The optimum conditions are listed, and the yield is said to be 45% acetylene, 9·2% ethylene, 5·3% carbon black, and 13% hydrogen. The purification is by absorption in water and flashing off in four stages to 90% and by refrigeration and scrubbing to 97%.

This is compared with the Sachsse process, which burns preheated methane and oxygen and quenches the flame with water within 0·01–0·001 sec. The cost of this is very low compared with the Hüls process, but the design and control of the burner is difficult and critical.

The Wulff process cracks hydrocarbons at high temp and low pressure. The products are quenched after a fraction of a second for reaction, and equal proportions of acetylene and ethylene are formed.

The relative merits of these processes are assessed with respect to electricity and fuel consumption, cost of feed stocks, capital investment, and by-products. D. H.

161. Delayed-coking unit charges 9,300 brl daily. O. A. Fuchs. *Oil Gas J.*, 26.10.50, **49** (25), 76.—The new unit of the Pan.-Am. Southern Corpn at El Dorado, Ark., refinery is described. Unit employs hydraulic decoking and is designed to charge 9300 b.s.d. of 13° A.P.I. reduced crude and produce 1950 brl of C_4 — 400° E.P. gasoline, 5240 brl of gas oil for catalytic cracking charge, and 420 tons coke per stream-day.

Coking furnace is designed to heat oil rapidly to coking temperature without coking tubes, oil flow being through radiant section only.

An eight-stage centrifuge pump delivering 700 g.p.m. at 1900 p.s.i.g. is used for decoking, the high-pressure water being delivered to cutting jets.

The coke flows by gravity from drums to a dewatering basin, whence it is dragged to storage for loading purposes, the dragline system being capable of moving 145 ton/hr out of the basin to temporary storage, which permits further water drainage.

A flow sheet is given, and a table shows expected yields. G. A. C.

162. Patents. D. C. Davidson, assr to Shell Development Co., U.S.P. 2,508,014, 16.5.50. Catalytic reforming of gasoline with hydrogen and using an impregnated molybdenum oxide–alumina catalyst promoted with silica.

W. R. Riggs, assr to Sinclair Refining Co., U.S.P. 2,509,745, 30.5.50. Fluidized catalyst process for conversion of hydrocarbons.

K. M. Watson, assr to Sinclair Refining Co., U.S.P. 2,509,751, 30.5.50. Fluid catalyst process for conversion of hydrocarbons with stripping and regeneration of fouled catalyst.

W. G. Annable, assr to The Pure Oil Co., U.S.P. 2,510,673, 6.6.50. Reforming gasoline consisting of the steps: (1) separating a naphtha fraction into two fractions with different boiling ranges, (2) subjecting the second fraction to thermal reforming, (3) separating the reformed products into two fractions, (4) separating the fraction boiling between about 300° and 400° F into two fractions one of which is rich in aromatics and olefins and the other rich in paraffins and naphthenes, (5) subjecting the paraffins and naphthenes to thermal reforming, (6) recovering a fraction boiling up to 300° F and a fraction boiling between about 300° and 400° F rich in aromatics and olefins, and (7) blending together as gasoline. C. F. S.

Polymerization

163. Kinetics of cuprene growth. A. E. Léger and C. Ouellet. *Canad. J. Res.*, 1950, **28B**, 358.—The author studied the kinetics of the polymerization of acetylene to cuprene on a copper catalyst between 200° and 300° C. This was done monometically in a static system. The max velocity of the autocatalytic reactions shows a first-order dependence on acetylene conc. The temp coeff changes abruptly at 280° C; the reaction is retarded by small amounts of oxygen, but accelerated by pre-oxidation of the catalyst. The apparent activation energy changes from 10 k.cal per mol to 40 k.cal. per mol at 280%. Hydrogen, carbon monoxide, and nitric oxide are found to have no effect on the reaction velocity. A. D.

164. Studies of the microheterogeneity of polybutadiene and G.R.-S. I. The propagation mechanism in the polymerization of butadiene. J. Longfield, R. Jones, and C. Sinertz. *Canad. J. Res.*, 1950, **28B**, 373.—When *n*-butyl mercaptan is reacted in a 1 : 1-ratio with butadiene in an emulsion system containing persulphate, no 1 : 2 and 3 : 4 addition took place, but 1 : 4 addition gave crotyl *n*-butyl thio-ether as the sole product. Certain physical properties of this and methyl vinyl carbonyl *n*-butyl thio-ether, which was also synthesized, were determined. The authors concluded that in all free-radical attacks on butadiene the terminal carbon is attacked. The resulting radical may or may not resonate between structures which yield 1 : 2 and 1 : 4 addition. The results obtained indicate that the overwhelming number of initiations are made by butyl mercaptan radicals and that termination is almost exclusively made by mercaptan. A. D.

165. Degradation of Polystyrene. I. A study of the polymerization and depolymerization of polystyrene. D. S. Montgomery and C. A. Winkler. *Canad. J. Res.*, 1950, **28B**, 407.—The steady state obtained when toluene solutions, containing the same total wt conc but varying proportions of styrene and polystyrene, were exposed to ultra-violet light at elevated temp was shown to depend on catalytic conditions. Hence this state does not represent a true thermal equilibrium between monomer and polymer. If no monomer present, polystyrene in toluene solution underwent chain scission on irradiation with ultra-violet light or treatment with benzoyl peroxide and air. If both present under the influence of light or large quantities of oxidizing agents, a steady state from polymerization of monomer and degradation of polymer was only a transient phenomenon. When the monomer is polymerized the degradation is dominant. The authors claim that their experimental results indicate that a given mass of benzoyl peroxide or air brought about the scission of a definite number of linkages, resulting in a definite decrease in the relative visc, but in the absence of oxidizing agents or light, polystyrene in toluene is very stable at 100° C. A. D.

166. Degradation of polystyrene. II. The synthesis and degradation of polystyrene possessing the Kuhn–Schultz chain length distribution. D. S. Montgomery and C. A. Winkler. *Canad. J. Res.*, 1950, **28B**, 416.—When styrene is polymerized in emulsions, polystyrenes of known mol. wt. are obtained, chain-length distributions corresponding to Kuhn–Schultz distribution. A relation has been thus established between intrinsic visc and number average mol. wt. for the above polystyrenes. If this form of distribution is unaltered on degradation, visc measurements give the average number of

scission points per structural unit. Benzoyl peroxide caused this scission at 80° C and 100° C, but none was obtained if this was absent even at 144° C. The authors estimate that number of scission points is proportional to mass of benzoyl peroxide added and that scission appears to be random over range investigated. A. D.

167. Degradation of polystyrene. III. The scission of polystyrene by a variety of agents and the role played by the solvent in this process. D. S. Montgomery and C. A. Winkler. *Canad. J. Res.*, 1950, **28B**, 429.—A relation has been established between intrinsic and relative visc of a 16% solution in toluene for polystyrenes possessing the Kuhn–Schultz chain-length distribution but different mean chain length. This should aid the study of scission process under conditions similar to those used by Mesrobian and Tobolsky. This relation did not distinguish between scission points introduced during polymerization and those due to degrading action of benzoyl peroxide and air. If the polystyrene used possessed the above distribution, then the authors showed that the average No. of scission points per mol was linear function of mass of benzoyl peroxide added and number of hr exposure to light. Thermal degradation has been studied with and without toluene present and role of solvent in scission process investigated. A. D.

168. Viscosity studies of a branched polystyrene copolymer. O. J. Walker, Jr., and C. A. Winkler. *Canad. J. Res.*, 1950, **28B**, 298.—The relation $\pi_{sp/c} = \pi + k^1[\pi]^2$, ($k^1 = 0{\cdot}39$) is satisfactory for the visc of polystyrene (prepared at various temp) in toluene at dilute conc. When styrene was copolymerized with quantities of divinyl benzene insufficient to cause gelation, the visc–conc relation changed, resulting in values of k^1 from 0·50 to 0·84. The authors concluded that the polystyrene molecule is normally linear. A. D.

169. Patents. J. E. Troyan, assr to Phillips Petroleum Co., U.S.P. 2,508,734, 23.5.50. Emulsion polymerization with a composition comprising diazo thioether–ferricyanide–mercaptan–dihydroxy aromatic compound.

C. S. Carlson, R. S. Merrington, and F. A. Biribauer, assrs to Standard Oil Development Co., U.S.P. 2,508,744, 23.5.50. Propylene polymerization with gaseous BF_3 as catalyst.

J. H. Bartlett, assr to Standard Oil Development Co., U.S.P. 2,509,203, 30.5.50. Describes the process for preparing polymerized alkyl fumarates by esterifying fumaric acid with C_{13}–C_{14} alkyl alcohol using an acidic catalyst, and after heating to refluxing temp, polymerizing in the presence of 0·1–5% of a peroxide catalyst.

A. P. Giraitis and K. J. Whittet, assrs to Standard Oil Development Co., U.S.P. 2,510,882, 6.6.50. An improvement in an aqueous emulsion polymerization process for the production of rubbery materials, which comprises adding to the polymerized emulsion 15–35 parts by wt of a stabilizing agent from the group consisting of phenyl-β-naphthylamine and di-β-naphthyl-*p*-phenylenediamine, 12·15 parts by wt of an alkanol, 0·1–0·5 parts of a colloidal clay, and 0·2–1·0 parts of an emulsifying agent from the group gum arabic and casein. C. F. S.

Alkylation

170. Patent. A. J. Abrams and C. S. Kuhn, assrs to Socony-Vacuum Oil Co. Inc., U.S.P. 2,509,028, 23.5.50. A method of producing gasoline by alkylation and reforming using hydrogen fluoride catalyst. C. F. S.

Isomerization

171. Patent. J. E. Storment, assr to Phillips Petroleum Co., U.S.P. 2,508,434, 23.5.50. Liquid-level control for use in a mixed-phase isomerization process for the isomerization of *n*-butane to *iso*butane. C. F. S.

Chemical and Physical Refining

172. Hydrodesulphurization of heavy petroleum oils. E. C. Hughes, H. M. Stine, and R. B. Faris. *Industr. Engng Chem.*, 1950, **42** (9), 1879–82. (*Divn Pet. Chem., 115th Mtng. Amer. Chem. Soc., San Francisco.*)—High-sulphur gas oils were reduced in sulphur content to those of gas oils from sweet crudes by mild hydrodesulphurization using cobalt oxide–molybdenum oxide–aluminium oxide at 750° F, 300 p.s.i.a. 1·0 vol/vol/hr, and 1000 cu ft. H_2/brl of charge. In some cases part of the charge was in liquid phase. Distribution of S between paraffinic–naphthenic fraction and aromatic fraction before and after desulphurization was determined by silica-gel fractionation and S analyses. Reduced crude was distilled, and asphalts were prepared from the bottoms. R. G. T.

173. Patents. E. Manning, assr to Shell Development Co., U.S.P. 2,508,038, 16.5.50. A process is described for refining hydrocarbons by treating with an anhydrous mixture of sulphuric and phosphoric acids.

L. T. Devol and W. J. Ayers, assrs to Tide Water Associated Oil Co., U.S.P. 2,508,817, 23.5.50. Sweetening mercaptan containing light hydrocarbon oils suitable for motor fuels, by dissolving in the oil an oil-soluble *NN'*-dialkylparaphenylenediamine in the presence of oxygen. C. F. S.

Special Processes

174. How Ethyl makes anti-knock. J. H. Schaeffer. *Chem. Engng*, 1950, **57** (8), 102–4.—The nine stages in the production of T.E.L. at the Baton Rouge plant of Ethyl Corpn are outlined. The inter-dependence and integration of these units is stressed. The starting points are ethylene, produced from hydrocarbon oil by cracking to coke; hydrogen chloride from the Mannheim process or from the elements; sodium by electrolysis of local brines; pig lead, and atmospheric nitrogen. Some of the ethyl chloride made from ethylene and hydrogen chloride is reacted with a 90% lead–10% sodium alloy in autoclaves to produce T.E.L. It is blended with ethylene dichloride and dibromide and dyes. D. H.

175. Action of electrical (corona) emission (discharge) on Natural gas. S. Pawlikowski. *Nafta*, **5**, July–Aug. 1949, Oct. 1949, Nov. 1949, 182–90, 267–72, 297–305.—After describing the nature of the corona discharge and apparatus used the author describes experimental condensation of ionized methane:

$$2CH_4 \longrightarrow H_2 + C_2H_6 \longrightarrow C_3H_8 \longrightarrow C_4H_{10}, \text{ etc.}$$

Experiments on oils containing various kinds of hydrocarbons show that their behaviour depends on their structure, but all are cracked.

In different conditions $CH_4 \longrightarrow C_2H_4 + C_2H_2$. All reactions are chain-reactions. Various theories are given to explain these reactions. Detailed description of electrical and chemical apparatus follows. Chemical analysis and physical properties of mixture of gases before and after discharge showed that two immiscible layers are formed. The lower contained mostly water-formed with oxygen from some activated charcoal. The hydrocarbon layer was fully analysed. Its sp. gr. was 0·722–0·766. A heavy oily layer remained in the apparatus. Its sp. gr. = 0·970. Catalytic action and chemical reactions on additions of CO, CO_2, and H_2O are described as well as tabulated. Over 75 papers are quoted. M. S.

176. High quality–high yield carbon black. J. T. Cox. *Chem. Engng*, 1950, **57** (6), 116–17.—Conditions and control of process required for high quality and yield of carbon black are summarized. The apparently small yield of 1·0–1·2 lb of carbon from 1000 standard cu. ft. containing *ca* 32 lb carbon is explained. 40% is used to heat the flame to 2600° F, and the contact time in the flame allows only 24% conversion of the remainder. D. H.

177. Patents. F. H. Bruner, assr to The Texas Co., U.S.P. 2,508,743, 23.5.50. High-pressure low-temperature catalytic conversion of CO with an iron catalyst.

J. P. Bilisoly, assr to Standard Oil Development Co., U.S.P. 2,509,204, 30.5.50. An improved catalyst for the catalytic conversion of CO and H_2 consisting of 40–95 parts by weight of MgO, 3–50 parts by weight of Fe_2O_3, 0·5–20 parts by weight CuO, 0·5–10 parts K_2O, and 25–51 parts of CoO.

W. W. Crouch, assr to Phillips Petroleum Co., U.S.P. 2,509,483, 30.5.50. An improved process for the production of thiol esters is described, where mercaptans are contacted with a gaseous ketene in the presence of an inert solvent.

I. Kirshenbaum, assr to Standard Oil Development Co., U.S.P. 2,509,869, 30.5.50. Hydrocarbon synthesis using CO and H_2 with an iron-type catalyst.

J. J. Owen, assr to Standard Oil Development Co., U.S.P. 2,509,878, 30.5.50. Aldehydes are formed by dissolving a cobalt soap in a liquefied olefin, adding alcohol to retard gelation, and charging the resulting solution and Co and H_2 to a reaction zone.

W. G. Frankenburg and E. T. Layng, assrs to Hydrocarbon Research Inc., U.S.P. 2,510,096, 6.6.50. An improvement in the process for the synthesis of hydrocarbons and oxygenated hydrocarbons where the stream of reactant gas supplied to the catalyst is regulated to a composition containing about 15% CO, less than 1% water vapour, and having an H_2 : CO ration of at least 3 : 1. C. F. S.

Metering and Control

178. Description of time measurement according to the Danish system Joergensen–Weibel. J. H. P. Koot. *Ingenieur*, **62** (43), 0·39.—With the condenser–chronograph type Joergensen–Weibel it is possible to measure small time intervals with an accuracy better than 0·2%. The method is based on the classical condenser principle. A condenser of known capacity is discharged through an ohmic resistor of known value during the time interval to be measured. This method is suitable for field measurements and for laboratory tests.

Two coils, two photo-cells, or two microphones are used as terminals for the velocity measurements of artillery projectiles and of small-arms bullets. To determine the propagation of velocity of longitudinal sound waves in elastic solids, two normal piezo-electric gramophone pick-ups are applied. The purpose of these measurements is to examine dynamical properties of materials, as a relationship seems to exist between the velocity of sound waves in the examined solid and the strength and structure of the material.

The apparatus built according to the described principle is simpler in construction and less expensive than the existing normal "counter"—chronographs. R. R.

179. Continuous viscosity control. W. M. Trigg. *Chem. Engng*, 1950, **57** (5), 156–7.—A simple controller and indicator of the visc of products such as enamels for coating wire is detailed. A pump delivers a constant vol of liquid to a metering tube carrying pressure connexions at each end. The differential pressure is recorded, and these impulses can be connected to the normal pneumatic controller. Control is stated to be accurate to within 0·2 cp, and a change of less than 0·1 cp observable. With two such instruments at different temps, V.I. can be controlled. D. H.

180. Patent. M. L. Arnold, assr to Richfield Oil Corpn., U.S.P. 2,508,881, 23.5.50. An instrument for the control of process variables. C. F. S.

Products.

Chemistry and Physics

181. Raman spectra. Hydrocarbons and oxygenated compounds. W. G. Brann, D. F. Spooner, and M. R. Fenski. *Anal. Chem.*, 1950, **22**, 1074–114.—This paper presents the Raman spectra of 119 compounds in the form of graphs and tables. In addition to the spectrum number the table lists the physical properties and where known the purities of the compounds. J. S.

182. The kinetics of the thermal decomposition of normal paraffin hydrocarbons. III. Activation energies and possible mechanisms of molecular reactions. K. U. Ingold, F. J. Stubbs, and C. Hinshelwood. *Proc. Roy. Soc. A*, 24.10.50, **203** (1075), 486.—At constant temperature the rate of the fully inhibited decomposition was determined for a series of initial hydrocarbon pressures; this procedure was repeated for 10° intervals over a 60° C range. With the aid of rate-pressure curves it was possible to determine the activation energy for a number of different pressures for each paraffin. Hydrocarbons used were ethane, propane, *n*-butane, *n*-pentane, *n*-heptane; tabulated results are presented. For higher hydrocarbons the activation energy falls off rapidly with increasing pressure. Experiments of the variation of surface/vol ratio and on the coating of the vessel surface with potassium chloride have been made for the normal reaction and for the reactions inhibited by nitric oxide and propylene. The effect of the surface change is either negligible or to accelerate a condensation which may vitiate measurements of the true decomposition rate. A reaction nearly of the first order predominates at lower pressures, and one nearly of the second order at higher pressures. The influence of hydrogen is discussed. Results indicate that the activation energy for the higher paraffins (C_5 and C_7) is a function of the pressure, but this is not so for ethane and propane. Butane is intermediate in character. The explanation of the different modes of reaction probably demands an extension of the usual theory of molecular reactions. D. K.

183. Calculation of the free enthaply of formation of hydrocarbons from group contributions. D. W. Van Krevelen and H. A. G. Chermin. *Ingenieur*, **62** (38), Ch. 65.—A correlation between structure and free energy of formation of hydrocarbons is proposed, applying the principle of additivity of group contributions. By means of this correlation it is possible to predict with reasonable accuracy the free energy of formation. A large part of the paper is occupied by tables and molecular diagrams. R. R.

184. Influence of vibration-coupling on the reactivity of hydrocarbons. R. Ubbelohde. *Rev. Inst. franç. Pétrole*, 1949, **4**, 488–501.—Recent physical data on hydrocarbons are reviewed to assess relative importance of effect of neighbouring groups on energies of electrons taking part in a bond (electronic theory) and effect of vibrations of a neighbouring group interacting with vibrations of a given bond (vibration-coupling). Discussion restricted to oxidn of hydrocarbons and their simple derivatives in the gas phase. E. B.

185. Influence of walls and gas diluents on the ignition region of hydrogen. J. Elston and P. Laffitte. *Rev. Inst. franç. Pétrole*, 1949, **4**, 502–8.—Variations in the ignition region of hydrogen are discussed for three tubes, having different dia and distance between electrodes, when H_2 is diluted with various gases. E. B.

186. Mass spectroscopic detection of intermediate reaction products. G. C. Eltenton. *Rev. Inst. franç. Pétrole*, 1949, **4**, 468–76.—A description of technique in determining intermediates in the decomposition and combustion of simple hydrocarbons. E. B.

187. Reaction of hydrocarbon radicals. H. W. Melville and J. C. Robb. *Rev. Inst. franç. Pétrole*, 1949, **4**, 477–87.—Molybdenum and tungsten trioxides are used as competitors for H atoms in measuring the efficiency of fast reactions of atomic hydrogen with olefins. Blueing of the oxide is taken as a measure of the number of H atoms reaching it after allowing for effect of alkyl radicals. E. B.

188. Reactions of methyl radicals with *cyclo*propane, ethylene oxide, methanol and dimethyl ether. M. K. Phibbs and B. De B. Darwert. *Canad. J. Res.*, 1950, **28B**, 395.—The above reactions have been investigated between 100° and 250° C, the methyl radicals being produced by the photochemical decomposition of dimethyl mercury, the reaction vessel being a quartz cylindrical cell. Activation energies for the abstraction of hydrogen from the compound by methyl radicals varied from 8·0 for dimethyl ether to 10·2 for *cyclo*propane, while the probability factor was about 10^{-4} for all the compounds investigated. A. D.

189. Influence of the wall condition and history on the ignition temperatures of hexane–air mixtures. E. Freling. *Rev. Inst. franç. Pétrole*, 1949, **4**, 454–8.—Ignition temp were measured in clear and opaque fused silica vessels of similar dimensions. Critical pressure varies with nature of walls but pressure–temp curves retain same shape. Ageing of walls increases the induction period of cold flames and normal ignition temp. E. B.

190. Temperatures of spontaneous ignition of diethyl acetal–air mixtures. P. Dugleux. *Rev. Inst. franç. Pétrole*, 1949, **4**, 447–53.—A study of the effect of concn, inert gas, and combustion-cylinder dia on the different regions of the pressure–temp diagram. E. B.

191. Kinetic study of air–diethyl acetal and air–hexane mixtures; generalizations regarding paraffin hydrocarbons. P. Dugleux and E. Freling. *Rev. Inst. franç. Pétrole*, 1949, **4**, 459–67.—At high temp ignition diagrams of paraffin hydrocarbons show a normal flame region defined in a simple curve and a peninsula due to the ignition of CO formed in the slow oxidn. A given temp corresponds with one pressure limit of ignition. The acetal curves are similar. E. B.

192. Spontaneous ignition and combustion kinetics of diethyl acetal. P. Dugleux. *Rev. Inst. franç. Pétrole*, 1950, **5**, 178–94; 244–65; 295–305.—Study of air–acetal mixtures shows that four types of phenomena can occur; at low temp (220°–450° C) there are cold flames giving rise to no change of pressure and whose induction period is short, usually below 1 sec; slow oxidn accompanied by blue luminescence and during which reaction velocity remains fairly const; normal ignition at 480°–500° C (at atm pressure), studies with admixture of inert gas indicate this to be a chain reaction; delayed flame (600°–700° C) with a long induction period (up to 1 hr), latter is probably due to effect of CO on vessel walls. Effect of concn, pressure, temp, vessel dia, and inert gas on these regions was comprehensively examined. V. B.

193. On the rapid combustion of methane. E. Audibert. *Rev. Inst. franç. Pétrole*, 1949, **4**, 446.—An interpretation of the mechanism of the reaction $CH_4 + O_2 \rightarrow 2CO + 4H_2$ involving the formation of methyl hydroperoxide. E. B.

194. Kinetics and inhibition of methane ignition. A. van Tiggelen. *Rev. Inst. franç. Pétrole*, 1949, **4**, 439–45.—The two modes of inhibition in the ignition of methane are examined; breaking of chains by walls and by chem reactions. E. B.

195. Contribution to the synthesis of organic deuterium compounds. I. Deutero-polymethylene. L. C. Leitch, P. C. Gagnon, and A. Cambron. *Canad. J. Res.*, **28B**, 256.—An improved method of preparing polymethylene $(CH_2)_n$ by the decomposition of diazo methane is described. Using the same method, a new polymer polyethylidene $(CH_3.CH)_n$ was obtained from diazo ethane. The decomposition of diazo methane–O_2 led to the synthesis of a new deuterated polymer $(CD_2)_n$. A. D.

196. The applications of polyamides as artificial raw materials. C. Maters. *Ingenieur*, **62** (31), Mk 81.—The chemical composition and synthesis of the polyamides are briefly indicated—the appropriate chemical reactions being shown in each case. The bulk of the article concentrates on the mechanical properties of these materials, of which one named " Akulon " is dealt with at some length. The applications of polyamides and particularly those of the product mentioned by name, such as the use as component parts of textile machinery, are dealt with in detail. Discussion following the paper is also reported. R. R.

197. Rheological behaviour of aluminium stearate-mineral oil systems. R. Rager. *Rev. Inst. franç. Pétrole*, 1950, **5**, 311–17.—Studies were made on pure Al stearate (5·9% Al) freed from free fatty acid and K_2SO_4, dissolved in transformer oil (d 0·883, mol. wt. 310, paraffins 41%, naphthenes 56·5%, aromatics 2·5%). Visc/temp curve of a 2% solution shows normal behaviour till transition temp (90° C) (at which solution becomes homogeneous) is reached when visc rises rapidly with temp to reach max at 100° C. Visc increase in range 90°–100° C is fifteen times. Repeated visc deter-

minations at 100° C show steadily falling value till stable condition is reached after 150 hr, this stable condition coincides with loss of plasticity (*i.e.*, flow/pressure curve is a straight line passing through origin). For a 4% solution of Al stearate in the same oil 300 hr is required to reach stability. On cooling to room temp such solutions become unstable and change to thixotropic gels. Visc/time curve of the 2% solution, at 94° C, is of similar shape to visc/temp curve, *i.e.*, at temp intermediate between transition point and temp of max of visc/temp curve, system passes through a stage of max visc. Visc/time curve at 88·5° (*i.e.*, 1·5° below transition point) showed visc of mixture to be const over 48 hr. Analogous results were obtained using a lub oil of *d* 0·921, mol. wt. 242, paraffins 38%, naphthenes 42%, aromatics 20%. V. B.

Analysis and Testing

198. The analytical process in chemistry. P. J. Elving. *Anal. Chem.*, 1950, **22**, 962–5.—The basic stages in the analytical process are discussed, with emphasis on the acute problems of isolating the material in a state suitable for measurement itself. The former problem is considered on the basis of general techniques available for separating and segregating substances by chemical and physical methods. The process of measurement as applied to chemical substances is considered on the basis of the discriminatory power of the type of measurement used—*i.e.*, ability of the measurement to distinguish between different substances. Fundamental principles of physical measurement as used in analysis are outlined. J. S.

199. Use of physical constants in analysis. E. H. Gilmore, M. Menaul, and V. Schneider. *Anal. Chem.*, 1950, **22**, 892–6.—Charts showing the relation between structure and refractive index, density, and boiling point of representative liquid halogen compounds and compounds of carbon, hydrogen, and oxygen are presented. The way in which these charts can be used to shorten and simplify the analysis needed in connexion with research work is described and illustrated. J. S.

200. Analysis of natural gas. M. Shepherd. *Anal. Chem.*, 1950, **22**, 881–5.—Two volumetric methods of absorption-combustion are compared by studying the results of the analysis of a standard sample of the natural-gas type. One method depends upon the measurement of contraction on burning and carbon dioxide produced; the other adds to these the measurement of the oxygen consumed. The latter method, though not in general use, is shown to be more accurate. J. S.

201. Analysis of a carbureted water gas. M. Shepherd. *Anal. Chem.*, 1950, **22**, 885–9.—The comparison of volumetric chemical methods and mass-spectrometer methods of analysis of carbureted water-gas are discussed. It is shown that mass-spectrometer methods are superior to chemical methods, although the spectrometric methods need considerable improvement in the determination of hydrogen and particularly carbon monoxide. A combined physical–chemical method of analysis will probably offer the best solution for gases of this type. J. S.

202. Classification of methods of quantitative analysis. E. J. Serfass, R. G. Steinhardt, and F. C. Strong. *Anal Chem.*, 1950, **22**, 966–9.—Representative existing classifications of analytical chemical methods are critically surveyed on the basis of several fundamental criteria. The basic difficulty is shown to be confusion of definition of the various operations. An improved classification is presented which generally satisfies the fundamental criteria for a satisfactory system, eliminates most of the difficulties inherent in present systems, and is capable of serving as the basis of an improved indexing system. J. S.

203. Determination of arsenic in insecticides. J. T. Odencrantz and W. Rieman. *Anal. Chem.*, 1950, **22**, 1066–7.—A method is proposed for the determination of total trivalent and quinquevalent arsenic in insecticides. The feature of this method is the separation of all interfering cations from the arsenic by passage through a column of hydrogen-ion exchanger. The arsenic in the elute is then determined by conventional iodometric procedures. This method requires less time and space than the distillation procedure. J. S.

204. Direct microdetermination of oxygen in organic compounds. A. O. Maylott and J. B. Lewis. *Anal. Chem.*, 1950, **22**, 1051–4.—A comparison of the ter Meulen, Liebig, and Unterzuacher methods for determining oxygen in organic compounds is presented. The ter Meulen method proved unsatisfactory for nitrogen compounds because the alkali hydroxide used to absorb water selectively and exclude ammonia was found to be inefficient for complete retention of the water formed. Oxygen obtained by Liebig's method has ascribed to the oxygen value the sum of all the errors of carbon and hydrogen evaluation. The method gives inaccurate results on samples leaving a mineral ash if components of the residue undergo change in weight during ashing. The Unterzaucher method gives incorrect results on organic compounds containing inorganic carbonates or oxides. Sulphur-containing compounds produce hydrogen sulphide, carbon disulphide, and carbonyl sulphide, and these gases are not retained by an Ascarite or potassium hydroxide scrubber. These sulphides can be retained by a liquid nitrogen trap, otherwise these compounds will release iodine and iodine pentoxide giving erroneous results. J. S.

205. Quantitative spectrochemical analysis of ashes, deposits, liquids and miscellaneous samples. E. K. Jaycon. *Anal. Chem.*, 1950, **22**, 1115–18.—A general technique is described which is applicable to the quantitative spectrochemical analysis of a wide variety of materials. Sample preparation, the incorporation of spectrochemical buffers, and excitation procedures are discussed for typical cases which illustrate the scope and possibilities of the method. Examples include the analysis of the ashes of rubber, plastics, paper, and cloth; deposits on walls of vacuum tubes and other surfaces; water, oils, and other liquids; and miscellaneous solid materials. J. S.

206. Spectrochemical analysis of brines. R. G. Russell. *Anal. Chem.*, 1950, **22**, 904–7.—A spectrographic procedure for the analysis of most of the cations in brine solutions utilizes an alternating-current spark form of excitation on 0·5-in briquets combined with a series of synthetic standards. A relative standard method is used to obtain concentration of the major constituents. Advantages and disadvantages of the method are discussed. J. S.

207. Spectrophotometric determination of anthracene in crude anthracene cakes. F. P. Hazlett, R. B. Hannan, Jr., and J. H. Wells. *Anal. Chem.*, 1950, **23**, 1032–6.—An ultra-violet method for determining anthracene in anthracene cakes is described that is at least as accurate as any known chemical method and is much more convenient. The results are within about 1% of the known concentration in synthetic cakes. Spectrophotometry has also been applied to the analysis of mixtures of anthracene, phenanthrene, and carbazole. A method of correcting for extraneous background absorption is outlined which assumes only that the background is linear. It is unnecessary to know the intensity of the extraneous absorption. J. S.

208. The ratio method in spectrophotometric analysis. J. A. Perry, R. G. Sutherland, and N. Hadden. *Anal. Chem.*, 1950, **22**, 1122–5.—A method has been developed for normalized spectrophotometric analyses of multicomponent mixtures in which only the mutual relationships of absorption coefficient are determined rather than the absolute values. The method has been used to analyse mixtures of the xylene isomers, the diethylbenzene isomers and *sec*-butylbenzene, and of benzene and of toluene. The method is rapid and accurate, and has been shown to effect a considerable saving in time and materials relative to older methods. J. S.

209. Separation of cracked gasolines by chromatographic absorption. Factors affecting efficiency of separation. D. F. Fink, R. W. Lewis, and F. T. Weiss. *Anal. Chem.*, 1950, **22**, 858–63. This paper describes the important variables affecting the efficiency of separation of complex hydrocarbon mixtures. The sharpness of separation between hydrocarbon classes in a given column increases as the particle size of the gel is reduced. For a given gel-particle size the sharpness of separation of a gasoline containing aromatics plus olefins in a quantity slightly less than the calculated gel capacity is directly proportional to the length and inversely proportion to the square of the diameter of the column used—*i.e.*, separation efficiency aL/D^2. Good separations of catalytically cracked gasolines into saturates, olefins, and aromatics can be obtained

in a column having L/D^2 (cm/sq. cm) = 230 if 100–200 mesh gel is used or $L/D^2 = 80$ if " through-200-mesh " gel is used. To obtain max sharpness of separation the gel should be packed into the column to the greatest extent; the quantity of aromatics plus olefins in the sample should be slightly less than the calculated gel capacity; the sample should be forced into the adsorbent column as completely as possible before the eluting agent is added; the hydrocarbon front should travel at a linear rate of 1–20 mm/min; and an eluting agent should be chosen which will give a sharp interface with the hydrocarbon mixture at the percolation temp used. Columns made from black iron pipe are as efficient as smooth-walled glass columns, and are more easily packed with finer gel. J. S.

210. An electronic image converter and its use in chromatography. Z. V. Harvalik. *Anal. Chem.*, 1950, **22**, 1149–51.—An electronic image converter and its accessories, enabling observation of textures and colour reactions of adsorption columns illuminated by an infra-red light source, are described. The converter employs an image tube, Type CV-147, which converts infra-red into visible light. The colour sensitivity of the tube also permits observation of ultra-violet light. The colour range of this device is 300–1400 m, and its magnification power 2·5 ×. It is suggested that the converter be applied to medical, criminological, and industrial investigations as well as to problems in analytical chemistry. J. S.

211. Chromatographic analysis of gas oils for hydrocarbon types. R. J. Clerc, C. B. Kincannon, and T. P. Wier, Jr. *Anal. Chem.*, 1950, **22**, 864–7.—In analyzing mineral oils, gas oils, etc., in the terms of groups of molecules of the same hydrocarbon type, chromatography has been outstanding in the separation of the sample into fractions which contain a single hydrocarbon type. Three chromatographic methods of analysis were examined in the study of the hydrocarbon-type composition of a straight-run gas oil and a catalytically cracked gas oil. The use of a weak developer to displace a saturate band and to elute several aromatic bands allows the desired separations into saturates, monocyclic aromatics, dicyclic aromatics, and tri-cyclic aromatics. The fractions recovered thus are suitable for further characterization by measurement of spectral and other physical properties. J. S.

212. Colorimetric determination of sodium pentachlorophenate. G. R. Walin. *Anal. Chem.*, 1950, **22**, 1168–9.—Two methods have been developed for the determination of sodium pentachlorophenate. (i) Sodium pentachlorophenate is precipitated from water by copper sulphate, forming a purple solution which dissolves without loss of colour in 70% *iso*propyl alcohol acidified with sulphuric acid. Potassium ferrocyanide is added, and the colour is measured with a spectrometer.

(ii) Methylene blue hydrochloride combines with sodium pentachlorophenate quantitatively at a pH of 10·9, producing a blue-coloured complex which is soluble in chloroform. The colour is measured with a photo-electric colorimeter. The copper method is superior because of its wider range and greater simplicity. J. S.

213. Infrared analysis of certain C_1–C_4 hydrocarbon mixtures. J. D. Stroupe. *Anal. Chem.*, 1950, **22**, 1125–8.—Infra-red analytical methods have been developed for the direct determination of small amounts of ethane, propane, *n*-butane, and *iso*butane in natural and purified methane streams. Accuracies of $\pm$ 0·1% are obtained with the permanent gas-absorption cell of the Bechmann IR-2 spectrophotometer. An additional comparison cell set permits the direct determination of methane to within $\pm$ 0·5%. The methods have proved satisfactory in routine applications for the past two years. J. S.

214. Infra-red–mass spectrometer combination method for light hydrocarbon analysis. M. J. O'Neal, Jr. *Anal. Chem.*, 1950, **22**, 991–5.—A method is presented for the complete analysis of C_1–C_4 paraffin-mono-olefin hydrocarbons (including differentiation of *cis*- and *trans*-2-butene) without the usual low-temperature distillation or other separation methods. A simple total pressure computation allows all components (including total butenes) to be based upon mass-spectrometer data and the butene split to be made by means of infra-red data. The resulting analysis takes advantage

of the superior accuracy for butenes and retains the accuracy and wide range of applicability of the mass spectrometer to other light hydrocarbons. J. S.

215. Application of the partition coefficient method to analysis of aldehydes and acids in connection with engine tests. O. Widmaier and F. Mauss. *Rev. Inst. franç. Pétrole*, 1950, **5**, 168–77; 239–43.—Determination of lower aldehydes and acids is desirable in exhaust gases of I.C. engines, rotating without ignition, as part of the study of the preliminary oxidn of hydrocarbons. Method is described whereby aldehydes are removed by scrubbing gases with heptane in presence of small amount of water to absorb HCHO. Estimation is carried out by multiple washing of heptane solution with water and titrating the two phases with hydroxylamine hydrochloride (cf. Abs. No. 297, 1949). Results are calculated from a knowledge of the partition coeff of formic, acetic, propionic, and butyric aldehydes between heptane and water, which were determined and which are presented graphically. The four corresponding acids are separated by scrubbing with water which is subsequently processed with heptane and ether and the heptane, ether, and aqueous solutions titrated. By calculations likewise based on the partition coeff of the acids between heptane and water it is possible to calculate the content of butyric, propionic, and acetic + formic acids, the two latter not being distinguishable by this procedure. Full experimental details and examples of calculations are given. V. B.

216. Analysis of colloidal electrolytes by dye titration. H. B. Klevens. *Anal. Chem.*, 1950, **22**, 1141–4.—The determination of total amounts of surface-active material present in a system can be obtained by titration with a suitable dye solution. Anionic soaps can best be determined with cationic dyes, and vice versa. Total amount of surface-active components, as well as the amount of each component can be determined in soap mixtures in soap–electrolyte systems, and in soap solutions containing other materials such as hydrocarbons, polar compounds, lattices, and various adsorbants if the proper experimental techniques are employed. In the case of determinations in turbid or slightly coloured media, reproducible results were obtained only with dyes that show changes in fluorescence intensity. Experimentally, the most consistent data were obtained by observations made in a darkened room using a narrow beam of light falling on a thin layer of the soap solution. J. S.

217. Adsorption analysis by displacement techniques. G. U. Dineen, C. J. Thompson, J. R. Smith, and J. S. Ball. *Anal. Chem.*, 1950, **22**, 871–6.—A displacement technique is described for the determination of saturates, olefins, and aromatics on small samples in the boiling range from 200°–325° C. Variables affecting this method of analysis are discussed. A dilution procedure is described which is helpful in the analysis of samples which do not show a satisfactory olefin adsorptogram plateau by the displacement technique.

A method is described for the determination of paraffins and *cyclo*paraffins in hydrocarbon mixtures in the naphtha boiling range. The method uses adsorption to separate the saturates from the sample, and the boiling point and refractive index to determine the percentage of paraffins and *cyclo*paraffins. J. S.

218. Separation of cracked gasolines by chromatographic adsorption. Adsorbent characteristics and regeneration techniques. D. F. Fink, R. W. Lewis, and F. T. Weiss. *Anal. Chem.*, 1950, **22**, 850–7.—The accurate engine evaluation of the hydrocarbon group constituents of cracked gasolines depends upon a satisfactory method for separating these stocks into saturate, olefin, and aromatic portions. The National Bureau of Standards has developed a method for accomplishing the desired separation on a small scale for analytical purposes by means of chromatographic adsorption on silica gel. The paper describes the adsorbent characteristics and regeneration techniques necessary for the most efficient and economical operation of a large-scale adsorption column. Silica gel supplied by the Davidson Chemical Company had the greatest capacity for adsorbing toluene from *iso*-octane and was most responsive to regeneration. Most alkyl benzenes in the gasoline boiling range appear to be adsorbed to about the same extent by silica gel (20 ml/100 g from a 20% vol solution in *iso*-octane). The capacity of silica gel for adsorbing olefins in the same range of molecular weights increases in the order straight-chain olefins < branched-chain olefins < cyclic olefins.

The amount of gel required to separate a given volume of solution containing saturates, olefins, and aromatics can be calculated fairly accurately by taking into consideration the percolation temp, the change in capacity with concentration of the material to be adsorbed, and the effect of olefins in reducing the capacity of the gel for aromatics. The volume of solution that can be separated by a given weight of adsorbent is increased by about 0·4% for each ° C lowering the temp of the column. Polymerization of the olefins can be prevented by using gels that have been tempered or reactivated at about 100° C and cooling by the column below 0° C during percolation. The gel is deactivated by extended contact with the eluting agent at high temperatures and pressures. Polar solvents also tend to decrease the adsorbent capacity of the gel under regeneration conditions which appear to be less pronounced with acetone.

J. S.

219. Separation of nitrogen compounds by adsorption from shale oil. J. R. Smith, C. R. Smith, Jr., and G. U. Dinneen. *Anal. Chem.*, 1950, **22**, 867–70.—Shale-oil distillates in the boiling range above 400° F contain large amounts of nitrogen compounds which complicate the efforts to determine the composition of these distillates. The content of these nitrogen compounds may be as high as 50% on some fractions. A procedure is described for separating shale-oil distillates into two fractions, one containing primarily hydrocarbons and the other primarily nitrogen compounds. The separation is based on the selective adsorption of the nitrogen compounds by Florisil a synthetic magnesium silicate. Factors investigated in selecting optimum conditions for the process are discussed. Results obtained on several shale-oil distillates are given. J. S.

220. Buffer for high pH measurements. W. D. Tuddenham and D. H. Anderson. *Anal. Chem.*, 1950, **22**, 1146–8.—A calcium chloride–hydroxide buffer system has been devised having a reproducible pH in the range of 11–12·65, depending on the concentration of calcium chloride. Such buffers are useful in checking the performance of pH meters and electrodes in this pH range. A study of the precision of glass-electrode measurements in this range indicates that their precision is largely dependent on the variability between electrodes. J. S.

221. Polarographic determination of elemental sulphur in petroleum fractions. M. E. Hall. *Anal. Chem.*, 1950, **22**, 1137–9.—A polarographic procedure is described for the determination of elemental sulphur in petroleum fractions. Evaluation with synthetic mixtures has shown the method to be accurate to $\pm 2\%$ of the elemental sulphur content in the range of 1–100 p.p.m. The method is rapid (about 20 min/sample), sensitive, and free from interference from organic sulphides, disulphides, and thiophene.

J. S.

222. Analysis of East Texas virgin naphtha fractions boiling up to 270° F. M. F. Bell. *Anal. Chem.*, 1950, **22**, 1005–14.—The individual paraffins and naphthenes in complex hydrocarbon mixtures boiling up to 270° F can be determined by infra-red spectroscopic procedures combined with distillation and percolation methods. A method for the complete analysis of the individual C_7 and C_8 naphthenes boiling between 190° F and 270° F is reported for the first time. By applying these methods the composition of two East Texas naphtha fractions boiling in the 115°–215° F and 215°–270° F ranges have been determined. Quantitative data on three *n*-paraffins, thirty-four *iso*-paraffins, twenty-two *cyclo*pentane homologues, and ten *cyclo*hexane homologues are presented; these hydrocarbons comprise all the compounds of their respective types boiling up to 270° F, with the possible exception of some of the C_9 *cyclo*pentane homologues. J. S.

223. Simultaneous determination of ethylene and propylene chlorohydrins. W. A. Cannon. *Anal. Chem.*, 1950, **22**, 928–9.—Ethylene and propylene chlorohydrins are determined simultaneously with an average error for ethylene chlorohydrin and 2·0% for propylene chlorohydrin. The mixed chlorohydrins are hydrolysed to glycols by heating with sodium bicarbonate in sealed bottles. The glycols are oxidized with periodic acid, and the acetaldehyde and formaldehyde are determined polarographically

after a simple distillation. The method is applicable to mixtures of ethylene and propylene chlorohydrins in water solutions or water-soluble solvents. The principal limitation to the method is that there must not be present or formed any volatile substances polarographically reducible at the same potential range as the aldehydes. The presence of monohydric alcohols or moderate concentrations of hydrochloric acid, aliphatic dichlorides, or dichloro-ethers does not interfere with the determination.
J. S.

224. The chemistry of ethylene oxide. I. An analysis for ethylene oxide. A. M. Eastham and G. A. Latremouille. *Canad. J. Res.*, 1950, **28B**, 264.—A new and more accurate analysis for ethylene oxide is described. This takes advantage of the quantitative oxidation of glycol by periodic acid. Analyses are obtained using as reagent 1% periodic acid in dilute perchloric acid. The time required is less than 1 hr, and precision about 0·1–0·2%. No attempt has been made to use this method at temp greater than 25%. A. D.

225. Application of the distribution law to analytical polarography. B. E. Gordon and L. C. Jones. *Anal. Chem.*, 1950, **22**, 981–7.—A method of polarographic analysis of compounds having the same or closely similar half-wave potentials is proposed. It is an adaptation of the method of Osburn and Werkman, which is based on differences of distribution of these materials between two immiscible solvents. The method, although applied to polarographic analysis, can be used when any measurement, physical or chemical, is made to determine the aggregate sum of the individual components in one of the solvents. The tentative name "partition polarography" is proposed for this particular application. Formulas have been deduced which predict the probable accuracy of such a method and permit selection of optimum experimental conditions for each system with a minimum of experimental work. The method has been applied to the analysis of mixtures of acetaldehyde, propionaldehyde, and *n*-butyraldehyde. J. S.

226. Titration of bases in nonaqueous solvents. J. S. Fritz. *Anal. Chem.*, 1950, **22**, 1028–9.—Organic bases may be accurately titrated in glacial acetic acid, benzene, chlorobenzene, nitrobenzene, chloroform, ethyl acetate, diethyl ether, petroleum ether, and acetonitrile using methyl violet as indicator. The titrant employed is a solution of perchloric acid in glacial acetic acid. Potentiometric titrations in most of the above solvents may be conveniently made with a pH meter using a glass–silver electrode combination without a salt bridge. Small amounts of water do not interfere, but larger amounts of water, alcohol, dioxane, and acetone should be absent. J. S.

227. Molecular still. M. Priznar, W. A. Wilt, and F. C. Nachod. *Anal. Chem.*, 1950, **22**, 1065–6.—A vertical-type molecular still is described which has been used successfully in the distillation of natural products which proved refractory to conventional distillation techniques. J. S.

228. Accurate control and vaporizing system for small liquid flows. H. F. Calcote. *Anal. Chem.*, 1950, **22**, 1058–60.—A system has been developed for accurately metering very small liquid flows of the order of 0·005 ml/sec, and a chamber constructed for vaporizing the liquid and mixing it with air. Any liquid may be used without individually calibrating the apparatus. J. S.

229. Evaluating petroleum residua and lubricating oil distillates. N. W. Furby. *Anal. Chem.*, 1950, **22**, 876–81.—A laboratory method for fractionating petroleum residua and lubricating-oil distillates employs adsorption fractionation of a 200-g sample. By blending fractions, oils are obtained covering the entire range of composition from very low to very high V.I. Property–yield relationships are obtained for this range, including gravity, viscosities, V.I., percentage sulphur, micro-solid point, and refractive index. Data are presented for three petroleum residua from different types of crude oil, one solvent extract, and one lubricating-oil distillate. Yields of treated oils of any V.I. may be accurately estimated. J. S.

230. Determination of helium in natural gas. J. J. Głogoczowski. *Nafta*, Dec. 1949, **5**, 340–2.—Deals with purposes and methods of helium determination. This is followed by description of apparatus used in Cracow University and of the theoretical considerations involved. M. S.

231. Determination of trace metallic components in petroleum oils by means of the emission spectrograph. M. T. Carlson and E. L. Gunn. *Anal. Chem.*, 1950, **22**, 1118–21.—A method is presented whereby trace metals occurring in oils in concentration ranges of 2–100 p.p.m. may be determined by direct spectrographic inspection of carbon electrodes impregnated with the oil sample. The method employs the cathode-layer principle with the use of added internal standards. The method is rapid and provides results of better than semi-quantitative accuracy over the established calibration ranges. Calibration procedures for the determination of iron, nickel, chromium, vanadium, calcium, sodium, silicon, and aluminium are described, and applications of the techniques are discussed. J. S.

232. Test for sediment in fuel oil by extraction. B. E. Jackson. *Anal. Chem.*, 1950, **22**, 952.—A method of overcoming the difficulty caused by water clogging the thimble has been devised which allows the extraction to be completed without interruption for drying the thimble in an oven. It is based on the fact that water and benezene (the extraction solvent) distill azeotropically but separate into two phases on condensation. J. S.

233. Fisher takes over TAG line of petroleum-testing instruments. Anon. *Laboratory*, 1950, **20** (1), 10.—Petroleum-testing equipment of the " TAG " line, founded by C. J. Tagliabue, and including many instruments manufactured in accordance with A.S.T.M. specifications, will, in future, be made by Fisher and distributed under the registered trade-name " Fisher-Tag." The equipment includes colorimeters, chromometers, viscosimeters, cloud and pour-test apparatus, Pensky-Martens flash-point testers, Cleveland open-cup flash testers, etc. Historical aspects of the development of some of the instruments are described, and in particular, those with which G. M. Saybolt was associated. C. N. T.

234. A new approach to the evaluation of wool oils for resistance to oxidation in storage. Mid-West Section Amer. Ass. Textile Chem. *Amer. Dyestuff Rept.*, 1950, **39**, 633.—The more important requirements and properties of wool lubricants are outlined. A particular source of difficulty is oxidation stability. The results of available accelerated oxidation-test methods, such as the Mackey test, do not correlate well with the actual performance of mineral-base oils under storage conditions, although they are reasonably accurate for saponifiable oils. The need for a reliable evaluation method is stressed. The drawbacks are described of the Fade-Ometer test, used for evaluating mineral oils often blended with saponifiable oils to produce worsted oils, and also for distinguishing conventionally from specially-refined mineral oils.

A three-week test at 120° F has been proposed, and its reproducibility investigated by six laboratories, using eleven different types of oil. The same products were aged under natural conditions, and also in two other accelerated tests. Discoloration effects were observed, and the effects of the oils on the scouring and dyeing properties of wool were determined.

The results showed that there was : (1) excellent correlation between the proposed test and natural ageing in all laboratories, and (2) poor correlation between Fade-Ometer tests and natural ageing, and between individual Fade-Ometers. The characteristics of the oils tested are not discussed, and no attempt is made to rate the oils, since the work was done solely with the object of developing a better test method. C. N. T.

235. Surface films and particle size determination of powders. V. R. Gray. *Canad. J. Res.*, 1950, **28B**, 277.—The surface pressure–area relation could be studied for a layer (one particle thick) of any powder or water using conventional film-balance techniques. A special sprinkler was developed for placing the powder on the surface, and flotation agents were adsorbed on particles which normally do not float.

Although all films collapsed readily on compression, a point in the compression curve

could be defined which repeats a rigid film. The author states that the thickness of this film was a definite fraction of the mean particle dia measured by microscopic methods. This fraction varies with ease of agglomeration and shape of particles.

A. D.

236. Pigment particle size. J. H. Martin. *Paint Mnfr*, Nov. 1950, **20** (11), 405.—The latest trends of thought on absolute particle-size determinations are reviewed. The election microscope has advanced the knowledge available on frequency and habit of smaller-sized particles, but the smallness of the sample makes its representativeness doubtful. Alternative methods available for the determination of particle-size characteristics of a powder in the normal pigment-size range are sedimentation and the use of the centrifuge for classification into size groups, while turbidimetric, heat of wetting, absorptiometric, and diffusion methods are used for measurement of surface area. All methods are capable of giving comparative results on similar materials but do not give absolute figures.

There is a view that the determination of absolute particle size is not necessary, but the effects on performance of paint films must be correlated with pigment-particle size and dispersion. The effect of pigment grading and dispersion on the shelf life of paints is important. Most of the effects of pigment size on a paint system are more affected by surface-area properties than actual size distribution. Thus in optical microscope counting undue stress is laid in the number and size of particles measured, without sufficient allowance being made for those undetectable by the method. It is thought that it would be best to assess particle size of pigments as far as possible under conditions comparable to those in which they will be employed. Heat of wetting methods appear to have possibilities for the determination of comparative surface area. Gravity sedimentation methods have a low practical limit of about 1 μ due to long settling times and diffusion effects. The turbidimetric technique or a combination of this with the sedimentation method may offer the most convenient approach for the classification of pigments and extenders. The method of photographing the actual traces of particles falling in a medium has much to recommend it. There are fourteen literature references.

D. K.

237. Determination of free carbon in cured rubber stocks. I. M. Kolthoff and R. G. Gutmacher. *Anal. Chem.*, 1950, **22**, 1002–3.—A method is described for the determination of free carbon in cured rubber stocks. The sample is softened by gently boiling with *p*-dichlorobenzene and is then treated with *t*-butyl hydroperoxide in the presence of osmium tetroxide as catalyst. No difficulties are encountered in the filtration of the carbon black. The carbon black is washed with dilute nitric acid to remove acid-soluble inorganic fillers. The method has been successfully applied to natural rubber, GR-S, Butyl rubber, and neoprene. No correction is necessary.

J. S.

238. Determination of unsaturation of butyl rubbers and certain branched olefins. T. S. Lee, I. M. Kolthoff, and E. Johnson. *Anal. Chem.*, 1950, **22**, 995–1001.—The reaction of iodine monochloride with highly branched olefins and polymers is abnormal in that the addition products formed possess steric strains and tend to decompose. The products of decomposition react further with iodine monochloride, generally leading to high results in the determination of unsaturation. Based upon the fact that the addition of iodine monochloride to the decomposition product is not so rapid as the addition of iodine monochloride to the original olefin or polymer, new procedures have been developed for the determination of unsaturation of highly branched ethylenic substances. The procedures have been shown to give reliable results for such olefins as the di-*iso*butylenes and for such copolymers as isoprene butyl rubber and butadiene butyl rubber.

J. S.

239. Determination of oil in paraffin waxes. C. W. Layton. *Anal. Chem.*, 1950, **22**, 1168–9.—A rapid method has been developed for the determination of oil in waxes, in which the sample is chilled with dyed methyl ethyl ketone to −25° F, a portion of the solvent–oil mixture is filtered off, and an aliquot of the filtrate reacts with a sodium bisulphite solution in a skim-milk-test bottle. The oil is separated from the mixture

by centrifuging, and the volume is read. Results by this method check very closely with A.S.T.M. method D.721–47. This method is particularly suitable for samples of low oil content (under 5·0%), but with modification has been used for oil contents up to 75% successfully. The advantages of the method are simplicity, reliability, and speed. Approx ½ hr is required for completing the test. Another advantage is that it avoids evaporation of solvent and thus includes light oils if present in the determination.
J. S.

240. Useful relations for countercurrent distribution computations. P. L. Nichols, Jr. *Anal. Chem.*, 1950, **22**, 915–18.—Expressions have been developed for the prediction and evaluation of results from countercurrent distribution experiments. Included is a method for determining the number of transfers required for a given "degree of separation" and pair of partition coefficients. An approx relation is proposed for determining the number of transfers required to resolve composite peaks. J. S.

241. Nomograph for thermometer temperature correction. J. P. Cole. *Anal. Chem.*, 1950, **22**, 946–7.—The nomograph is designed for correcting the temp readings of total-immersion thermometers used in distillations carried out at atmospheric and reduced pressures. When partial immersion thermometers are used it is only necessary to correct for pressure. Details of the use of the nomograph are presented.
J. S.

242. Insulation test set, The British Thomson-Houston Co. Ltd., London. Anon. *J. Sci. Instrum.*, 1950, **27** (10), 286.—A new B.T.H.–Forrest insulation test set of smaller size than, but similar in principle to, the previous model, is described.

Operating from 230 V or 110 V 50 c/s mains, the apparatus comprises a step-up transformer and miniature high-voltage valve rectifier for providing the D.C. test voltage, which may be 1, 2, 3, 4, or 5 kV. Measurements of insulation resistance are made using a cathode-ray tuning indicator ("magic eye"), and extend over the range 5–60,000 MΩ. The max current is limited to 1 mA. A guard terminal is provided for excluding surface leakage of the insulator under test from the measuring circuit. An oil-cell is available as an accessory for use with the test set, so that measurements of the D.C. resistance of insulating oils can be made. This property, or its change during service, is regarded as a valuable guide to oil or insulation conditions, although definite limiting values as to insulation quality are difficult to specify. C. N. T.

243. A suggested relocation and respacing of the Union colorimeter scale for lubricating oil and petrolatum. D. B. Judd, L. Plaza, and M. A. Belknap. *Bur. Stand. J. Res.*, 1950, **44** (6), 559.—The recommended colours and tolerances for seventeen glass colour standards are given. J. T.

Crude Oil

244. Classification of crude oil on the basis of physico-chemical properties and commercial derivatives content. H. Burstin. *Nafta*, July–Aug. 1949, **5**, 190–5.—The short-comings and fallacies are described of the pseudo-scientific way of dividing crudes into paraffinic–naphthenic–asphaltic–mixed categories. Dissatisfaction is expressed with any variations of the above showing how they fail to predict the refining equipment necessary and qualities of all but one product.

Instead the Russian OST 8792/NKTP 2067 and its developments are recommended. The last one GOST 912–41 describes the crude by its: (1) sulphur content %; (2) asphalt content %; (3) paraffin content as pour point of fraction 7° E/50° C; (4) wt-% of petrol of given volatility; (5) its O.N.; (6) O.N. of tractor fuel; (7) sp. gr. of 7° E/50° C fraction (multiplied by 1000). Thus a certain crude from Grozny is classified as: low-sulphur, bituminous, high-paraffin, 14, 53, 8, 905. M. S.

Gas

245. Hydrocarbons from natural gas. H. H. Jones and J. T. Cox. *Chem. Engng*, 1950, **57** (7), 110–12.—A flow sheet and descriptive article emphasizes the unusual engineering features of a plant for recovering propane, butane, and heavier hydrocarbons from natural gas. Close control of the continuous stills enables sharp cuts to

be made. The neat plant and piping lay-out is enhanced by polished corrugated aluminium sheet as lagging. Throughput, operating conditions, column sizes, and steam requirements are detailed. D. H.

246. Liquefied petroleum gas—industry's standby. E. A. Jamison. *Chem. Engng*, 1950, **57** (5), 117–18.—Liquefied petroleum gas (L.P.G.) has increasing use as a standby fuel to ensure continuity of operation in the event of accidental curtailment or cut-off of natural-gas supplies, in cases where industrial gas is sold on an interruptible basis, and where peak load charges are high.

L.P.G. has the advantage over fuel oil as a standby that when mixed with air it can be used in lieu of natural gas through the same distribution and combustion system.

A numerical calculation of the economics of L.P.G. standby systems is given. D. H.

Engine Fuels

247. Present trends in motor fuel requirements. Anon. *World Petrol.*, 1950, **21** (8), 60–1, 102.—O.N. requirements are steeply rising with increase in C.R. of modern I.C. engines. Alternative, and cheaper, course to increasing 100 O.N. fuel is re-design of engines to take wider boiling-range and lower O.N. fuels. Texaco engine is claimed to be less sensitive to C.R., supercharge, and O.N. Trends in aircraft design indicate that in the U.S.A. demand for wide-range jet fuel (JP-3) will steadily grow for turbo-prop engines, and similarly for kerosine (DED. 2482) in Britain, Canada, and Netherlands. Increasing No. of spec for aviation spirit is adding to costs. Locomotive switchover from steam to diesel is largely responsible for rising demand for diesel fuels, which, if continued, will call for 130° F fl. pt. fuels, permitting max yields without sacrificing quality. E. B.

248. Vibratory phenomena accompanying constant volume combustion. R. Vichnievsky and B. Salé. *Rev. Inst. franç. Petrole*, 1950, **5**, 286–94; 327–35.—Review of previous work is given, followed by results of experiments made in three bombs of different shapes and dimensions with H_2/O_2 mixtures. Pressure fluctuations were measured by a recording instrument operated by change in elec capacity. Trials were also carried out with several single-cyl test engines, both spark ignition and C.I. Existence of vibratory phenomena, both in bombs and engines, is confirmed. Vibrations of a frequency 4000–25,000 were detected in the engine tests; combustion-chamber dimension is not the sole factor governing the frequency. Interpretation of the results obtained is difficult, and further data are required. The determination of combustion temp from the vibration frequency, as suggested by certain authors, is considered to be a procedure of very doubtful validity. V. B.

Lubricants

249. Extreme pressure lubricants—phosphorus compounds as additives. W. Davey. *Industr. Engng Chem.*, 1950, **42** (9), 1841–7.—A study of the extreme pressure properties of phosphorus compounds, blended in mineral oil, alone, and with fatty acids, esters, or sulphur has been made by the standard short-duration test in the four-ball machine. Phosphites are found superior to phosphates, and long-chain aliphatic esters superior to aryl esters. Fatty acids, esters, and sulphur improve the lubricating properties of phosphites and phosphates, and chlorinated phosphorus esters, thiophosphites, and thiophosphates are useful additives. The lubricating effect of the phosphorus compounds is of a lower order than is shown by halogen–sulphur additives and of the same order as the lead soap–sulphur-type additive. Lubrication by phosphorus esters is effected by chemical reaction with the steel to form phosphide films which wear down smoothly. Chloride–phosphide and sulphide–phosphide films are favoured by the corresponding esters. R. G. T.

250. Boundary lubrication of steel—blends of acids, esters, and soaps in mineral oil. W. Davey. *Industr. Engng Chem.*, 1950, **42** (9), 1837–41.—Blends of acids, esters, and soaps are used to effect boundary lubrication by adsorption of the additive on the metal surface to give a film with low coeff of friction, and low wear at small loads.

Fatty acids react chemically with the metals to give iron–soap films, which are highly stable, and resist seizure and wear. Esters are less effective, since soap formation takes place only under extreme conditions. The use of sulphur improves lubricating properties of the above chemicals by formation of a sulphide film facilitating adsorption of polar compounds. The results are discussed in the light of the mechanism proposed by Thorpe and Larsen. R. G. T.

251. Patents. F. J. Watson and R. C. Morris, assrs to Shell Development Co., U.S.P. 2,509,620, 30.5.50. A non-flammable hydraulic fluid made up of :—

	Parts by wt
Hexachlorobutadiene	100
Polymerized ester of methacrylic acid	2–15
Glycidyl *cyclo*hexyl ether	0·5–5
Tricresyl phosphate	3–15

B. Folda, assr to Socony-Vacuum Oil Co. Inc., U.S.P. 2,510,031, 30.5.50. Method of inhibiting evolution of hydrogen sulphide from sulphurized oil lubricants by adding, after removal of H_2S, an oil-soluble soap of a metal from the group lead, cadmium, copper, zinc, chromium, manganese, iron, nickel, and cobalt in proportions of about 4–75 parts by wt per 1000 parts by wt of sulphur.

S. A. Ballard, R. C. Morris, and J. L. Van Winkle, assrs to Shell Development Co., U.S.P. 2,510,540, 6.6.50. A synthetic lubricant comprising a mixture of homopolymeric ethers of 1 : 2-epoxy linear hydrocarbons.

P. J. Doyle and C. H. Flickinger, assrs to Republic Steel Corpn, U.S.P. 2,508,016, 16.5.50. Lubricating oil for use in rolling metal and consisting of an unoxidized aliphatic hydrocarbon mineral oil containing oxidized hydrocarbons and between about 0·01 and 2·0% of oxygen existing as organic acids, alcohols, and esters free from aldehydes and ketones, having a viscosity 95–605 sec Saybolt and 100° F, having an acidity value about 5·0 mg of KOH (A.S.T.M. Standard Neutralization Test), and less than 0·5% residual carbon.

R. G. Mastin, assr to Cities Service Oil Co., U.S.P. 2,508,617, 23.5.50. Coloured lubricating oil is obtained by reacting phenylhydrazine with a reagent from the group of dianisalacetone, anisalcinnimalacetone, and dicinnimalacetone in acetic acid solution.

H. V. Ashburn, R. S. Barnett, and O. P. Puryear, assrs to The Texas Co., U.S.P. 2,508,741, 23.5.50. A lubricating-grease composition comprising a synthetic liquid polyorganosiloxane and a metal soap. C. F. S.

Bitumen, Asphalt, and Tar

252. Patents. V. R. Smith and D. E. Stevens, assrs to California Research Corpn, U.S.P. 2,508,428, 23.5.50. A bituminous composition having good anti-stripping properties, consisting of bitumen and the salt of a polyalkylene polyamine and an organo-substituted inorganic acid.

V. R. Smith and D. E. Stevens, assrs to California Research Corpn, U.S.P. 2,508,429, 23.5.50. A bituminous composition having good anti-stripping properties, consisting of bitumen and the salt of a phenol and a polyalkylene polyamine.

V. R. Smith, D. E. Stevens, and E. W. Mertens, assrs to California Research Corpn, U.S.P. 2,508,430, 23.5.50. A bituminous composition having superior anti-stripping properties, consisting of bitumen and the salt of an organo-substituted inorganic acid, and a water-soluble, surface-inactive monoamine.

V. R. Smith, D. E. Stevens, and E. W. Mertens, assrs to California Research Corpn, U.S.P. 2,508,431, 23.5.50. A bituminous composition having superior anti-stripping properties, consisting of bitumen, and the salt of an organo-substituted acid of phosphorous and a monoamine.

V. R. Smith and D. E. Stevens, assrs to California Research Corpn, U.S.P. 2,508,432, 23.5.50. A bituminous composition having superior anti-stripping properties con-

sisting of bitumen and the salt of a polyamine and an organo-substituted acid of phosphorus.

P. E. McCoy, assr to Stancal Asphalt and Bitumuls Co., U.S.P. 2,509,574, 30.5.50. An oil-in-water-type bituminous emulsion, comprising by weight about 55–70% bituminous material, 30–50% water, and 0·05–5% of a salt from the group of ammonium dichromate and alkali-metal dichromates. C. F. S.

Special Hydrocarbon Products

253. Patent. W. H. Rupp and J. W. Packie, assrs to Standard Oil Development Co., U.S.P. 2,509,885, 30.5.50. An improvement in the preparation of *iso*butylene by contacting the acid extract with a saturated aliphatic hydrocarbon and separating a liquid hydrocarbon phase from the acid extract prior to the *iso*butylene regeneration step. C. F. S.

Derived Chemical Products

254. The fluorocarbons. J. H. Simons. *Chem. Engng*, 1950, **57** (7), 129–36.—Differences in the physical and chemical properties of fluorocarbons and their hydrocarbon analogues are stressed. The resistance to thermal decomposition and polymerization of fluorocarbons indicates that they may provide lubricants far superior to any hydrocarbon lubricants yet produced. The immense amount of work which has yet to be done to determine the properties and methods of manufacture of even the less complex homologues means that they will not be available for several years at best. Anomalous reports published previously are explained, and controversies such as the probable V.I. of these compounds and its effect on their usefulness as lubricants are considered rationally. Possible uses in the paints, fabrics, solvents, and aeronautics industries and as working fluids for heat engines are assessed. D. H.

255. Patent. J. L. Harlan, assr to Standard Oil Development Co., U.S.P. 2,509,863, 30.5.50. Method is described for producing divalent metal sulphonates by sulphonating a naphthenic petroleum fraction to obtain a mixture of oil and mahogany sulphonic acids, neutralizing with alkali-metal hydroxide solution, extracting the salts and oil with an alcoholic solvent, adding sodium chloride to the derived solution of mahogany sulphonic salts to salt out the sulphonic salts in an alcoholic layer, separately removing this layer and adding alkaline-earth-metal salt to combine with the sulphonates. C. F. S.

Miscellaneous Products

256. Review of pigment progress. W. M. Morgans. *Paint Mnfr*, Nov. 1950, **20** (11), 387.—A general review of literature published during the last year on the subject of pigments is presented. The main interest lies in improving the three leading white pigments. Several patents are concerned with the production of the rutile form of TiO_2 from the anatase type. Considerable interest has been shown in " anti-corrosive " pigments more especially those of the $ZnCrO_4$ type. The " Day-glo " poster inks which appeared during the year are an extension of the idea of incorporating a white fluorescent pigment in laundry chemicals. Cadmium pigments, in spite of a relatively high price, are still commanding considerable attention. They show excellent heat stability and are extensively used in compositions for thermo-plastic mouldings. The preparation and properties of channel and carbon blacks are briefly discussed. There is continued interest in phthalocyamine pigments. Other aspects under review are metallic powders, mineral extenders, lead, and iron oxide pigments. There are sixty-one literature references. D. K.

257. Progress in pigment dyestuffs. J. Smethurst and W. Carr. *Paint Mnfr*, Nov. 1950, **20** (11), 391.—A brief review is given of the development in pigment dyestuffs since 1920. The present-day trend is towards the improvement of existing products in such aspects as increase in strength, better light fastness, better solvent fastness, migration properties, softness of texture, and ease of dispersion. The present state and requirements of the printing-ink, paint, plastics, rubber, and textile-printing

industries are discussed. The introduction of daylight fluorescent pigments is one of the most interesting and important recent developments. The main source of information on this type of pigment is the series of patents taken out by the discoverers, the Switzer Bros. Moderate light fastness and limited range of colours are drawbacks. A satisfactory method of assessing light fastness is still needed. Evidence is accumulating that the use of actual outdoor daylight-exposure tests is the most reliable guide to light fastness. The wetting and dispersion of pigments are also discussed. D. K.

Corrosion

258. Materials selection chart. N. S. Mott. *Chem. Engng*, 1950, **57** (8), 197–200.—The most economical material satisfactory for resistance to corrosive media is indicated. 311 chemicals are listed, including organic solvents, acids and bases, trade wastes, acid gases, inorganic salts and their concentrations when important. D. H.

259. Electrochemical behaviour of zinc and steel in aqueous media. Part II. R. B. Hoxeng. *Corrosion*, 1950, **6** (9), 308.—It has been assumed for some time that zinc was always anodic to steel and cathodically protected it in all aqueous solutions. Instances have been noted in hot-water service, however, where the appearance of the corroded pipe indicated the possibility of the zinc being cathodic to steel. Experiments have shown that in the absence of oxygen the zinc was always anodic while in aerated solutions, bicarbonates and nitrates promoted cathodic zinc potentials and chlorides, sulphates, silicates, and calcium. All acted to give more anodic zinc potentials. The temp was found to be secondary to electrolyte composition in its effects on the electrochemical behaviour of zinc. J. T.

260. An electrochemical mechanism of corrosion inhibition by chromates, nitrites, and other oxidants. M. Pourbaix and P. van Rysselberghe. *Corrosion*, 1950, **6** (9), 313.—Polarographic methods are used in a theoretical and experimental study of inhibitors. Corrosion inhibitors may be classified as: (1) surface conversion inhibitors; (2) adsorption inhibitors; (3) diffusion inhibitors. A brief analysis of mechanism of each type is given. J. T.

261. The behaviour of the chromium nickel stainless steels in sulphuric acid. G. C. Kiefer and W. G. Renshaw. *Corrosion*, 1950, **6** (8), 235.—The corrosion rate of four commercial types of chromium–nickel stainless steels and one special type in sulphuric acid of 0–95% concentration at four temp 100°, 150°, 175°, and 200° F is given. The effect of addition of various sulphates and oxidizing agents to the acid on the corrosion rates is shown. The samples were tested in an activated state. At temperatures about 150° F all of the steels remain active in nearly all acid concentrations and corrosion rates are high, and below this temp the molybdenum steels are most resistant while increasing chromium content has some effect in lowering the corrosion rate. The addition of copper to molybdenum steels improves resistance considerably, although these steels behave similarly to copper and copper–nickel alloys in that they do not show a sharp passive–active boundary. The addition to sulphuric acid of various inorganic sulphates causes a marked lowering of corrosion rates. There is an indication that sulphates of metals below chromium in the e.m.f. series completely inhibit attack and provide a passive condition. The addition of oxidizing agents, such as nitric or chromic acid and dichromates, also completely inhibits the attack. J. T.

262. Corrosion mitigation within dehydrating tanks. E. O. Kartinen. *Petrol. Tech.*, June 1950, **2** (6), *A.I.M.M.E. Tech. Paper No.* 2947, 175–9.—The discussion is confined to corrosion in the water-exposed areas in dehydrating tanks. The water is at 80–160° F, and the salinity up to 25,000 p.p.m. Corrosion takes the form of pits, attack along bolt seams, and general attack. Usually steam-coils first show corrosion, then the shell and bottom areas. Protective coatings have been applied inside tanks, and these have had some degree of success. New coats may be needed every two to three years, even after thorough cleaning of the steel. Eventually vertically spiral coils were discarded for replaceable horizontal flat coils which could be removed through

clean-out openings. Galvanized tanks were employed, although more costly, and with no other protective coating than the zinc. Examination of a black iron coated tank after eighteen months showed that although the coat was still in place it was loose, with bad pitting beneath. A galvanized tank showed serious corrosion after seventeen months.

There are many problems in undertaking cathodic protection. Apparently with the more corrosive brines higher current densities are needed for protection. High-resistivity waters require a large number of anodes to keep down the voltage. In a galvanic anode drainage system a 16-lb magnesium anode in oilfield brine gave about 2 amp at 0·6 V. Since 5 mA/sq. ft. appears likely to give protection, it was deemed that 8 amps would suffice for 1603 sq. ft. of steel in hot brine if properly distributed. In the installation three 16-lb anodes in parallel formed one circuit between the two sets of coils, while three single-anode circuits were arranged with the anodes 5 ft from the tank shell and 7 ft from the floor. Lead wires passed through special bushings in the tank shell, and were grounded to the shell outside. A few days after installation the total current was 13·4 amps at 0·62 V, and resistances were introduced to reduce the current density to 5 mA/sq. ft. Three coats of plastic paint were applied inside, but after four months this had disintegrated, but the new heating coils were without pits. After a further 288 days the coils still had no pits, and there was no significant increase in corrosion elsewhere. A thin hard black coating was on the metal. It was concluded that the cathodic protection was proving effective.

Magnesium anode protection was estimated to cost $81/year; coil and tank replacement (two-year life without protection) would cost $1350/year. Thus a saving of $1269 resulted. G. D. H.

262a. Corrosion in condensate and in high-pressure sweet oil wells. R. C. Buchan. *Corrosion*, 1950, **6** (6), 178.—The problem of corrosion in condensate and in high-pressure wells producing sweet oil is discussed, and the work that has been done on these two problems is reviewed.

The use and relative value of materials that can be used for tubing and well-head assemblies are discussed in detail. These include low-carbon steel tubing, 9% nickel steel tubing, internally nickel-plated tubing, and plastic-coated steel tubing. Various chemicals used as neutralizing agents, emulsifying and/or wetting agents, and other film-forming materials are reviewed. The use of sodium silicate is discussed in detail, and the methods of determining the corrosive conditions and the efficiency of methods used to prevent corrosion are summarized. J. T.

263. Cathodic protection of fourteen offshore drilling platforms. E. P. Doremus and G. L. Doremus. *Corrosion*, 1950, **6** (7), 216.—During the past fifteen months over ½ million sq. ft. of submerged steel surfaces on fourteen drilling platforms and four drilling tenders in the Gulf of Mexico have been placed under cathodic protection with magnesium anodes. The practice is at present to use a high current density of short duration furnished by magnesium ribbon (Galvo-line) to deposit a calcareous coating on the surface to be protected. This polarization treatment reduces current requirements for the protection to a value approaching 3 mA/sq. ft., and therefore a relatively small "permanent" installation of 51-lb magnesium anodes serves to maintain both the coating and protective potentials upon dissolution of the Galvo-line. In general, a sufficient number of anodes is installed to provide protective potentials of −0·78 V minimum, referred to a saturated calomel electrode adjacent to the surface under test, with anode outputs uniformly adjusted to project a life of two to three years for the protective system. Methods of installing Galvo-line and the magnesium anodes are discussed and illustrated. Current and potential data obtained during the course of a typical installation are given, and experiences and results obtained during installations on several different types of structures are discussed. J. T.

264. A rust preventing pickling inhibitor. K. F. Hager and M. Rosenthal. *Corrosion*, 1950, **6** (7), 225.—A new class of pickling inhibitors has been developed which gives metal surface protection against sulphuric acid attack. A brief review is given of the properties of inorganic inhibitors, metallic salts having a relatively high overvoltage, and organic inhibitors, hydrocarbon–nitrogen–oxygen–sulphur compounds which adsorb on the cathode area and thus protect metal.

The Emulphor STH, a wetting agent, is found to be an effective inhibitor. Two types of steel were used to indicate the effect of composition on inhibitors: SAE 1010 and type 8617, HTS 3121, spec. AN-QQS-676. Increased inhibitor concentration improves percentage retardation but not proportionately, while minimum effective inhibitor concentration varies with steel composition. A method of calculating percentage of retardation is presented. J. T.

265. The influence of stress on corrosion. Parts I and II. J. J. Harwood. *Corrosion*, 1950, **6** (8), 249; **6** (9), 290.—The effects of stress on the internal structure and energy characteristics of metals in relation to their influence on corrosion reactions are discussed, with some emphasis on the nature and importance of residual stresses and the non-homogeneity of worked metals. Recent concepts of the nature of grain boundaries are reviewed, and their importance in stress-corrosion reactions is described. Stress may influence the nature, rate, and distribution of corrosion reactions in several ways: (*a*) by increasing the internal energy level of the metal and causing a possible shift of electrochemical potential in a more active direction, (*b*) by causing an intrinsic increase in the rate of corrosion, (*c*) by damaging the protective surface films, (*d*) by influencing polarization reactions, (*e*) by changing the metallurgical characteristics of the metal system in promoting phase transformations, precipitation, etc., (*f*) by accelerating the rate of corrosion by purely mechanical effects. The most serious effects of stress are in localized corrosion phenomena, *e.g.*, stress-corrosion and corrosion-fatigue. Stress-corrosion of alloys is particularly discussed, and the influence of metal composition and structure, environment, state, and degree of stress is given. Practically all known alloys can be made to crack from stress-corrosion in appropriate environment. The experimental evidence favours an electrochemical mechanism. However, the exact mechanism of cracking may vary from one metal to another, and no existing theory is adequate to account for all observed phenomena. Stress-corrosion cracking of α-brass, stainless steels, and magnesium alloys is not yet clearly understood. Methods of protection against stress-corrosion cracking are briefly reviewed. J. T.

266. Patents. K. F. Schiermeier and H. A. Poitz, assrs to Shell Development Co., U.S.P. 2,509,786, 30.5.50. A corrosion preventive composition for use as a rust inhibitor, comprising a major amount of a light hydrocarbon, from 5 to 25% of an oxidized waxy hydrocarbon, about 2–10% of a mixture of alkaline-earth metal salts of organic sulphonic acid, and about 1–5% of a non-aromatic alcohol.

D. C. Bond and M. Savoy, assrs to The Pure Oil Co., U.S.P. 2,510,771, 6.6.50. A method of protecting metal surfaces against hydrogen-sulphide corrosion by using a hardwood-tar distillate. C. F. S.

Engines and Automotive Equipment

267. Jet nozzles for aircraft gas turbines. W. O. Meckley. *Aero. Engng Rev.*, Oct. 1950, **9** (10), 33.—The jet nozzle accomplishes the last gas expansion in the gas-turbine cycle, and in a turbojet unit it is the final conversion unit in the system, converting pressure energy into thrust energy. The most commonly used design is simply a straight conical nozzle of fixed area, and a typical thrust-efficiency curve for this nozzle is given here. A promising development in turbojet design is the use of variable-area instead of fixed-area jet nozzles. A nozzle with variable area and properly integrated control should have the advantages of better fuel economy while cruising, more rapid increase of thrust during engine acceleration, cooler starting, and compensation for thrust variation among engines so that all turbojets in a multi-engined aircraft will give equal thrust. The general types of variable-area jet nozzles—"clam-shell" or "eyelid," plug, and flat or curved swinging-door types—are described. Jet-nozzle performance is discussed, and flow and velocity coefficients and jet thrust defined. Because of consideration of leakage around moving parts, added viscosity, and form effects, variable-area nozzles exhibit slightly lower thrust efficiencies than the fixed, conical nozzles, but this loss can probably be reduced by improvement in nozzle design. U. N.

268. The development of jet helicopters in France. A. Charriou. *Aircr. Engng*, Oct. 1950, **22** (260), 292.—An account is presented of the work being done at the Société Nationale de Constructions Aéronautiques du Sud-Ouest. One advantage of jet propulsion for helicopters is that the rotor blades are driven without mechanical transmission by ejection of the gases from the rotor-blade tips, and this mechanical simplification results in a reduction in both manufacturing and maintenance costs. With this type of propulsion there is a reduction in torque reaction, allowing the tail rotor to be dispensed with. The higher fuel consumption of jet engines is largely offset by the fact that helicopters are used over short ranges, and the weight saving can, in fact, be used to increase the useful load.

A brief history is given of the development of jet-driven helicopters at the S.N.C.A.S.O., from the filing of the first patent in 1944. Descriptions and illustrations are given of the first and second prototypes Ariel I and Ariel II. Ariel I was fitted with a Mathis G7 air-cooled radial engine driving, through a step-up gear, a Turbomeca centrifugal compressor. The gross weight of this version was 1875 lb. Ariel II, similar to the Mark I in general lay-out, is powered by a Mathis 8G·40 air-cooled, inverted-Vee engine, the step-up gear having a ratio of 8·82 : 1 for driving the Turbomeca centrifugal compressor. A third machine, a three-seater fitted with a 220-h.p. Turbomeca turbo-compressor, is under design and construction. U. N.

269. I.C. engines and gas turbines raising fuel economy. L. N. Rowley. *Chem. Engng*, 1950, **57** (5), 126–8.—Advances in stationary I.C. engines are summarized. Cheapness of natural and sewage gases has made duel-fuel engines competitive with diesels. Dual-fuel engines compress lean gas–air mixtures to *ca* 450 p.s.i. Ignition does not occur until a charge of oil 5% of the total fuel requirements is injected. These engines can work with any oil–gas ratio up to 100% diesel, and can be varied without stopping the output. Aluminium manufacture, which requires large direct currents, is turning over to gas engines because of the high cost of rectification. The special engines used are described.

Gas-turbine development is outlined. D. H.

270. New industrial diesel engine. Anon. *Mech. World*, 6.10.50, **128** (3325), 321.—The new diesel engine described is the 5·43-litre capacity, type 4 D.C. 330 made by Henry Meadows Ltd. It was developed to meet the demand for a powerful, yet compact unit suitable for vehicles with a load capacity of 6–8 tons. It is equally suitable, however, as an industrial engine for such applications as portable compressors, welders, and generating sets. The engine, which uses direct injection has four cyl of 120 mm bore and 120 mm stroke. Harmonic balancing gear takes out vibration due to secondary forces. Max governed speed is 2200 r.p.m., at which speed the engine develops 80 b.h.p. net. Max torque occurring at 1400 r.p.m. is 230 lb./ft. corresponding to a b.m.e.p. of 105 p.s.i. Crankcase and cylinder-block are in one piece in high-duty iron with full-length water-jackets surrounding the cyl. Forged from high-tensile alloy steel the five-bearing crankshaft is hardened by the Tocco process. All crank-shaft bearings are steel-backed, lined with copper–lead and lead–iridium treated. Connecting-rods of high-tensile steel are designed to permit their removal upwards through the bore. Other design features and performance figures are supplied in the paper. A. S.

271. Patent. J. W. Savin and J. H. Neithammer, assrs to The Atlantic Refining Co., U.S.P. 2,509,316, 30.5.50. Method and apparatus for determining plugging of oil rings of I.C. engines using a radial light beam. C. F. S.

Safety Precautions

272. Shell eyes eye injuries. D. M. Farrell. *Oil Gas J.*, 12.10.50, **49** (23), 99.—A four-year eye-protection programme of Shell Pipe Line Corporation, Houston, is reviewed and costs compared.

It was found that employees were not wearing eye-protection devices supplied because goggles were cumbersome and in some cases aggravated existing visual

discomfort. As a result, each employee had his eyes checked, and corrective-protective spectacle-type goggles supplied where necessary. The new programme has reduced estimated eye-care costs for 1950 to less than 10% of the 1949 figure. G. A. C.

273. Study of the I.F.P. No. 3 Wheatstone bridge hydrocarbon detector. E. Vellinger and R. Monicard. *Rev. Inst. franç. Pétrole*, Sept. 1950, V (9), 271–85.—The equipment has two platinum filaments traversed by a current and occupying two arms of a bridge. When both are in the same atmosphere the bridge is balanced, but if a gas with hydrocarbons is drawn past one the temperature will rise, the resistance will fall, and the balance will be disturbed. The temperature of oxidation of methane is relatively high, while the higher hydrocarbons oxidize at lower temperature.

A detailed study of the apparatus has been made, and the following factors have been examined: mode of presentation of gas, effect of filament temperature on sensitivity, the influence of the external temperature, of inert gases, the construction, activation, length, diameter, and form of the filaments. The sensitivity fell with increase in the amount of carbon dioxide present. The peak reading occurred at successively higher filament currents as the number of carbon atoms in the gas decreased. The longer the period of activation of the filament the greater the sensitivity, and there was an optimum proportion of iridium in the filament. The optimum coil spacing was 2–3/mm, and for 3·75 coils/mm, the optimum spiral length was about 8 mm. For given filament lengths the sensitivity increased as the coil diameter decreased. The orientation of the filament affects the sensitivity.

In the dynamic method 50 cc of gas is injected in about 4 sec with the filament heated; in the static method the apparatus is flushed with the gas and then the filament is heated.

Calibration curves are given, and an example is discussed. A series of notes on the use of the equipment are appended. Extensive use of the equipment has been made in examining cuttings for hydrocarbon gas at Pechelbronn. G. D. H.

Miscellaneous

274. Britain's refinery expansion shifting imports from products to crude. F. L. Lomax. *World Petrol.*, 1950, **21** (8), 50–6.—Review is given of progress in Britain's refinery expansion schemes with general description of the plant being erected. E. B.

275. 4·7 billion pounds of chemicals from four olefins. R. S. Aries and W. Copsulsky. *Chem. Engng.*, 1950, **57** (8), 116–17.—Statistics on the U.S.A. manufacture of chemicals from olefins, 1940–50. D. H.

276. Invention and improvement in the petroleum industry. Trawinski and others. *Nafta*, Oct. 1949, **5**, 284–8.—Following Soviet example an Invention and Improvement Commission has been set up by the Polish Institute of Petroleum. Examples of improvements are given: (1) "jerker" attached to the American "unit rig"; (2) a method for emptying trays full of paraffin wax; (3) absorber for light gases of distillation; (4) weld-seals for gas-pipes near inhabited buildings.

A report of the Commission for 1946–48 and resolution passed at Invention and Improvement Conference follow. M. S.

277. The six year technical plan of the State Corporation for Natural Gas. W. Kołodziej. *Nafta*, Sept. 1949, **5**, 226–8.—Natural gas is meant to take the place of gasoline and coal-gas. At the moment it is mainly used in the central industrial district as fuel in homes and for the steel industry. Plans for 1949–55 include expansion of pipelines, elimination of wasteful use, building of compressor stations, and general improvement of supplies. M. S.

278. Discussion on the six-year plan of the Polish petroleum industry. J. Czastka, J. Wojnar, S. Niemientowski, and M. Karpinski. *Nafta*, Oct. 1949, **5**, 278–83.—(*a*) Drilling by concussion depends on quality of tools. This lies outside the field of

influence of petroleum industry. Equipment suggested by Assn of Polish Petroleum Engineers in Borysław 1929–31 is better than the Pennsylvanian rig.

(*b*) Analysis of production from new and old wells shows a steady fall of about 14% p.a. This counteracts increases due to increase in drilling. The way to increase production is therefore through more new wells.

(*c*) Utilization of natural gas as planned by "Gaz Ziemny" does not include practical consideration of gas prices and meters, mains corrosion, etc. Problems of pressure and future expansion which were omitted in the original plan are pointed out here as well as the storage and odour of the gas. Building of mains will start in 1951.

(*d*) Whilst the plans laid down for refining expansion are considered sound, any development of solvent refining must be preceded by work on pilot scale. The production of high V.I. oils should be based on co-operation between the Polish Institute of Petroleum and the School of Petroleum Technology. Cracking processes for high O.N. gasoline should be investigated with an eye on more distant future. Since there will still be a shortage of lub oils, attention should be paid to processes of volatilization of heavier hydrocarbons such as that adopted by Germany during the war. M. S.

279. The six years technical plan of the United (State) petroleum refineries. S. Suknarowski. *Nafta*, Sept. 1949, **5**, 228–33.—Production of different items from home and imported crudes is to expand more than twofold. In the field of fuels this will cover 66% of 1955 consumption. In lubricants deficiency is expected to be similar to that in fuels. Refinery expansion plans include solvent refining but no cracking. Distillation will be improved by abolition of retort processes in favour of distillation columns. It is planned to import approx half of the crude required. M. S.

280. Six years technical plan of State Corporation for exploratory drilling. R. Piatkiewicz. *Nafta*, Sept. 1949, **5**, 218–22.—A review of the work of the Corporation, its successes and difficulties. Latter confine themselves mostly to rotary equipment and shortage of trained personnel. These and other shortages will be overcome during 1949–55 period. After UNRRA help was discontinued USSR has become the main supplier of equipment. M. S.

281. Invention and improvement in the (Polish) petroleum industry. W. Kulczycki and others. *Nafta*, Nov. 1949, **5**, 320–4.—In Part 1 author shows how inventiveness leads to great savings. Part 2 registers gains obtained through proper production and exploitation according to a method invented by Regula. Also an improved ventilating device in pumps. Part 3 deals with importance of continued training for employees. Part 4 is a list of inventions, etc., for September 1949, together with description of procedure and advantages to the industry. M. S.

282. Advances in petroleum refining. W. M. Holaday. *Oil Gas J.*, 12.10.50, **49** (23), 84.—Various refining techniques, including thermal cracking, reforming, coking, catalytic cracking, polymerization, alkylation, isomerization, polyforming, hydroforming, and gasoline treating and their relation to gasoline production are reviewed.

Figures show trends since 1930 in the anti-knock quality of regular and premium-grade gasolines sold in the U.S.

Figures also show foreign petroleum-product distribution and consumption; and relative production of fuel oils in the U.S.

Future processing techniques in the U.S.A. and Europe are discussed; and it is concluded that it will be some time before conversion of fuel-oil fractions to gasoline will be practised to any extent outside the U.S.A. G. A. C.

283. How to control welding quality in a petroleum refinery. A. F. Blumer. *Oil Gas J.*, 19.10.50, **49** (24), 94.—Principal points of welding control include selection of proper personnel by means of welders' qualification tests, inspection and observation of jobs in progress, sampling and evaluation of finished welds; constructive instructions to operatives who produce unsatisfactory work, and keeping of maintenance and welding records.

The development and use of suitable welding procedures, preparation of job specifications, testing, and evaluation of welding electrodes to compare merits and discover

suppliers of acceptable electrodes, and conducting research so that welding methods may be tested, evaluated, and their adaptability to refinery uses determined, are further aids to welding control. G. A. C.

284. Refrigeration removes moisture from compressor air lines. J. Partington, Jr. *Heating & Ventilating*, Oct. 1950, **47** (10), 69.—In industrial plants which use compressed air for motive power and control, care must be taken to ensure that the lines are kept free of water, otherwise there may be an interruption in the operation of machine tools and other air-operated equipment. Refrigeration is an important method of removing the moisture from the compressed-air supply. Presence of water may result in lubricating oil being washed from tools or machines, and the inadequate lubrication will result in excessive wear and therefore high maintenance costs. There will also be a lowering of efficiency, particularly where high-speed tools are concerned. A further effect of water may be corrosion of parts being manufactured where compressed air is used for blowing away chips or dust. In addition, severe damage of the air line may be caused. An example of this moisture problem is discussed in detail, and an analysis of the conditions shows the size of refrigerating unit which would be required to avoid moisture condensation in the typical design. A. S.

285. Check your design jobs. G. T. Austin. *Chem. Engng*, 1950, **57** (6), 137–8.—The responsibility of the chemical engineer in design extends to all the details such as convenience of operation; safety from fire and poisoning; adequacy of flooring, foundations, materials of construction; writing of reports to fire departments, future operators, and controllers of the plant, and to maintenance men. It provides from the author's experience a list of generalized questions which the designer should check to avoid the most frequent pitfalls in plant design. D. H.

286. Patents. J. A. Hipple, assr to Westinghouse Electric Corpn, U.S.P. 2,508,163, 16.5.50. Control scheme for mass spectrometers.

H. A. Hulsberg, assr to Universal Oil Products Co., U.S.P. 2,508,572, 23.5.50. Gas-analysing apparatus. C. F. S.

BOOK REVIEWS

The Economics of United States and World Oil. E. Ospina-Racines. Published by the author at Apartado Aéreo 49–45, Bogota, Colombia, 1950. Pp. 194. $25.

This useful volume is by the author of " Economics of Oil Investments in Colombia." In his foreword the author summarizes the book as a detailed study of the law of supply and demand in terms of U.S. and world oil, and describes it as an analysis of how the basic economic factors governing oil supply, demand, price, and time-lag of the U.S. oil industry, and other factors of the countries abroad can control and will govern the future development of the world oil industry.

The book divides itself into two main sections. The first four chapters cover the factors affecting demand and supply. The next three chapters are devoted to the economics of developing prospective oil lands. There follows a short chapter on the U.S. and world oil policies, and the book ends with a number of appendices giving useful background data and statistics in support of the main text.

In the first chapter the author develops an interesting theme in respect of long-term cycles in the development of the industry. These cycles are shown as covering the period pre-World War I; post-World War I to the present day, and it is assumed that the period of the third cycle has now started. The suggestion is made that the study of these cycles should act as a guide in timing oil investments. While the practical value of such guidance may be questionable, this chapter helps to analyse some of the forces that influence the ebb and flow of the industry's activity. In developing his theme the author concludes that as compared with an average U.S. crude price of $1·31 for the second cycle, an average of $1·60 may be postulated for the third cycle. On this assumption it is taken as a broad indication that demand will predominate over supply. While it is presumably not intended to be more than a generalization, this theory may well be received with a certain amount of scepticism in the light of past experience.

A chapter, well illustrated with tables and graphs, deals at length with the effects of price movements on the supply–demand relationship. Economic incentives to convert potential oil supplies into actual production are analysed in some detail, as also are the factors which govern conservation measures. The author also deals with the technicalities of M.E.R. and the tendency for economic factors to cause the technical maximum efficiency rate to be exceeded. Appropriate emphasis is placed on the ultimate cost to the consumer of governmentally-imposed price ceilings which are conducive to reduced exploration activity and profligate exploitation of existing resources. An appendix to this chapter which analyses the economic position of petroleum in relation to synthetic oil reaches the conclusion that petroleum is due to occupy the most prominent place as a low-cost liquid fuel for many decades ahead.

A further chapter analyses the growth of world demand during the past quarter-century and describes how the factors promoting this increase in demand may be significant in the near future. Taking the analogy of the manner in which Venezuelan and Colombian oil took up the overseas market demand for Mexican oil in the 1920s, the future competitive ability of the Middle East in relation to the Caribbean area is discussed in some detail.

The next chapter deals with the factors governing the variations in the pricing of crude oils of different qualities. Some useful reference material is provided on this inevitably complicated subject.

The next fifty-eight pages are devoted to an appraisal of the world's undiscovered oil land. The analysis of the probable extent of potentially productive areas is based upon an aggregation of the views of all recent authorities on this subject. The author then outlines the economic incentives for the development of these prospects and, in so doing, provides much useful information on investment costs. Some of the basic financial considerations associated with the development of the concessions in the Caribbean and the Middle East are also given.

The following two chapters are devoted to the appraisal of prospective oil land and the economics of attaining commercial production. Although these subjects could

be books in themselves, many useful data are provided. The conclusion is reached that the " up to 2 per cent possible commercial oil land " of the world is reduced to less than 1 per cent by the various factors that impede development. This material is likely to be instructive, not only to oil operatives but also to governments confronted with the problem of developing national resources in a competitive world.

The final chapter deals with national oil policies. Although there is understandable difficulty in providing an analysis of these policies, a bibliography summarizes the more recent works of reference on this subject.

There is scope for much more understanding of the basic economics of international oil, and objective studies of the subject are too few and far between. This book is consequently a welcome addition to the paucity of literature covering this particular field. O. T.

Petroleum Production Engineering: Petroleum Production Economics. Lester Charles Uren. London: McGraw-Hill Book Company, 1950. Pp. xiii + 639. 64*s*.

This latest addition to the well-known series of Production Engineering handbooks, by Professor L. C. Uren, will attract a wide variety of readers.

The author states in his preface that its purpose is to give the student of petroleum engineering, within the scope of a single volume, a perspective of the economic side of engineering and its application to his particular professional field, but it will also be very useful to petroleum geologists, refinery personnel, and oil-company executives, since it provides many authoritative data on the economic fundamentals which have and will continue to control the phenomenal expansion of the petroleum industry.

The handbook deals preponderantly with conditions in the U.S.A., and though there is good excuse for this, in that American interests have been so largely responsible for the rapid development, one could have wished for a little more information on conditions in other countries, particularly those whose present resources are not big but who are expected to have a significant position in the future.

The chapter on petroleum industry taxation might well be studied by legislators in many countries, as it describes and comments on the growth of this burden, which the author now considers to be a threat to industrial prosperity.

Other chapters deal with economic structure of the industry, geographic distribution of petroleum, oil-industry finance, labour management, materials and equipment, cost accounting, economic aspects of engineering, appraisal of properties, and conservation of natural resources.

The author is to be complimented on the way in which he has been able to include material data of most recent date on many subjects. E. C. S.

The Friction and Lubrication of Solids. F. P. Bowden and D. Tabor. Oxford: Clarendon Press, 1950. Pp. xii + 337. 35*s*.

It has been a pleasure to read this book. It is in the same tradition as the authors' original papers—clear and systematic in the development of each argument, and everything made as simple as possible.

The book is based on the authors' and their colleagues' work, and is a collection of their original papers, the matter being set out in proper order and brought up to date, and a few sections being added to make the story more complete. Their contributions being large and continuous for many years, the book becomes a substantial one. Thus there are chapters on the area of contact between solids, the surface temperature of rubbing solids, the effect of frictional heating on surface flow, the friction and surface damage of sliding metals, the mechanism of metallic friction, the action of bearing alloys, the friction of clean surfaces and the effect of contaminant films, the friction of non-metals, the boundary friction of lubricated metals, the mechanism of boundary lubrication, the action of extreme-pressure lubricants, the breakdown of lubricant films, the nature of contact between colliding solids, the nature of metallic wear, the adhesion of solid surfaces and the influence of liquid films, and chemical reaction produced by friction and impact. There is an appendix giving typical values of friction for a variety of solid surfaces and lubricants.

There are also author and subject indexes. Throughout an attempt is made to get to grips with the fundamental phenomena under each of these titles; the book is therefore essentially one for the specialist in this field and the would-be specialist. It is a book also that must be taken as a whole; there are no well-defined parts that will be of particular interest to different readers.

This being the first full-sized book dealing with boundary lubrication and related phenomena it will be widely welcomed. For this reason, however, it is important to be clear as to its scope. The authors are careful to point out in the preface that the book deals almost entirely with experimental researches carried out by them and their collaborators and colleagues. Because of the wide range of their work, however, and because in many places references are made to papers by other authors, and in a few places such other work is briefly described to make part of the story, the reader new to the subject and those many who never bother to read prefaces may easily jump to the conclusion that this book summarizes the whole subject up to date. This is not so, and what a pity! To have done this would, of course, have added considerably to the work involved, but the authors have read the literature and weighed it up in planning their work and writing their papers, and such a comprehensive book, written with the same clarity as this one, would indeed have put all workers in this field in their debt. This is a matter of regret rather than of criticism.

The weakest part of the book if one looks for something to criticize is the references to practice: comments are made on the importance of particular phenomena and results, but in rather too vague terms to carry conviction. Another point of importance is the coefficients of friction given in the Appendix. This is a welcome recognition of the needs of the practical man, but there is a considerable danger in it; the values will be used and quoted (*e.g.*, by compilers of handbooks) far beyond what is intended. The authors recognize this danger by putting a warning footnote to the main title to the effect that slight changes in the conditions of measurement lead to large variations in the coefficients of friction. It would have been justifiable, however, to have put this warning in heavy type under the title, to have made more of it in the way of quoting examples, and to have put a footnote referring to this point on each of the succeeding pages.

Overall, however, this book gives considerable satisfaction. It must be a matter of great pride to the authors to see the work of the past fifteen or so years integrate into such a worthy whole. The book is produced to the high standard expected of these publishers; it is profusely illustrated with the photographs and diagrams from the original papers. D. C.

Motor Oils and Engine Lubrication. Carl W. Georgi. London: Chapman & Hall, 1950. Pp. xii + 514. 68*s*.

"Up to 1945 automotive crankcase oils were classified in terms of viscosity only, other factors of oil quality or character not being considered. By that time developments in refining methods and treatments had led to an increased variety of oils which the Lubrication Committee, Division of Marketing, of the American Petroleum Institute has designated as follows—regular, premium and heavy duty types."

These words indicate that the book will explain the origin and functions of the new range of motor oils. But, before starting on the deeper story, he disposes of the myth that oils of lower and still lower viscosity are being popularized in the U.S.A. S.A.E. 20 and 30 oils still have the greatest sales. Then we are introduced to that almost mystical specification, 2-104B, and reminded that the average motorist tends to judge oil quality by the amount of oil he has to add to the crankcase between drain intervals, and warned that the practical value of very high film strength as secured by the incorporation of additives to motor oils is questionable except for abnormal conditions.

Georgi quite fearlessly debunks many postulates and energetically explains and expands all sorts of things which help us to appreciate the problems of lubrication.

Additives and engine testing are still very specialized, largely because they are developed by the specialist in laboratories where financial restrictions are not too obvious. The development of both demands a pretty high order of chemistry and

engineering, and a heavy financial burden. These restraints are apt to surround the subject with an atmosphere of mystery which is absolutely unjustified. The responsibility for engine testing must be placed upon the limitations of laboratory tests. Georgi tells us a lot about engine testing—quite sufficient to convince us of its necessity, and makes a gallant attempt to deal with the complexities of additives.

If we acknowledge that additives only improve mineral oils, then we must have sympathy with the chemists who endeavour to synthesize the perfect lubricant. Nowadays we hear a lot about synthetic oils, but little of their application. The time will come, however, when some of them at least will be used in quantity. The need for them was being felt at the end of the 1939–45 war. It is appropriate, therefore, that Georgi should devote a chapter to them.

The book is crowded with information both for the scientist and the salesman. Difficult problems of oil change, when additive oils should be used, oil consumption, deposits, engine wear, and many other things are discussed in considerable detail in a masterly fashion, as those of us who know the author and his contributions would expect. I must admonish him, however, for his devotion to American literature at the expense of publications in other countries. Only five British references!

E. A. EVANS

Erdöl, Mächte und Probleme. A. M. Stahmer. Kevelaer (Rhineland): Butzon & Bercker, 1950. Pp. 169. 8*s*.

This book appears to have been written so as to bring the average German oil man and others interested in the petroleum industry up to date after some ten years of being cut off from the events in the main producing and consuming areas of the world.

It starts off with a brief description of elementary technical and economic factors, and goes on to examine facts and figures in the spheres of production, refining, and distribution. Then it gives useful, if not always entirely accurate, information about the activities of leading oil companies. The survey is rounded off by a description of the policies of the several countries interested in oil as producers and/or consumers.

Though the book will undoubtedly fill a gap in the knowledge of German readers, it is obviously not designed for a public which is familiar with the literature available in English.

P. H. F.

BOOKS RECEIVED

Organic Reagents for Organic Analysis. By the staff of the Research Laboratory of Hopkins & Williams Ltd. 2nd Edition. Chadwell Heath, Essex: Hopkin & Williams Ltd., 1950. Pp. 263.

Since the first edition in 1944 this volume has been considerably enlarged, and the melting-point tables now occupy 110 pages. The remainder of the book is devoted to a general survey and details concerning a large number of selected reagents.

Properties of Lubricating Oils and Engine Deposits. C. A. Bouman. London: Macmillan & Co., 1950. Pp. 170 + viii. 15*s*.

Deals with the principles and problems of the lubrication and fouling of internal-combustion engines.

Technical Data on Fuel. Edited by H. M. Spiers. 5th Edition. London: World Power Conference, 1950. Pp. 517 + xv. 25*s*.

This is the first new edition of "Technical Data on Fuel" to be published for fifteen years, and every effort has been made to bring the information up to date and to include such new material as changed conditions in the fuel industries necessitated. It is of interest to note that the articles on fluid flow in pipes, fluid-flow measurement, heat transfer, ignition characteristics of gases, detonation, and diesel-fuel rating are among those which have been rewritten.

Originally designed in 1928 to provide technicians with agreed data for use in their calculations, the value of the work has increased as each edition has added more information to that of its predecessor.

Oil and Petroleum Year Book 1950. Compiled by Walter E. Skinner, London: W. E. Skinner, 1950. Pp. 280 + cxii. 15*s*.

Details of operations, directorate, and finance are given for 790 companies engaged in various phases of the petroleum industry.

Symposium in High Additive Content Oils. Philadelphia, Pa; American Society for Testing Materials, 1950. Pp. 63. $1·75.

The lubricating oils considered are of an entirely new type, and differ from the previous heavy-duty oils in that they contain from five to ten times as much additive. Developed to meet a field condition involving severe operation of engines using high-sulphur fuels, the success of these oils (identified as " Series 2 ") led investigators to determine if other problems such as sludging and piston and valve deposits in other than tractor engines could also be corrected by the use of these oils.

Following a short Introduction by A. H. Batchelder of the California Research Corp., the symposium includes the following four papers: " Does service performance justify higher quality lubricating oils? " W. B. Bassett; " High detergency motor oils," A. B. Roehm and C. O. Tongberg; " Five years' experience with special heavy-duty oils," J. A. Edgar and R. E. Jeffrey; " Possible future military engine oils for ground equipment," N. L. Klein.

This symposium, sponsored by A.S.T.M. Committee D-2, was presented at a meeting held in October 1949.

Symposium on Turbine Oils. Philadelphia, Pa.; American Society for Testing Materials, 1950. Pp. 52. $1·50.

The four technical papers comprising this symposium present a review of progress in turbine lubrication, and also consider some problems of the future. The papers and discussion comprising this symposium were delivered in October 1949, at a meeting sponsored by A.S.T.M. Committee D-2.

Following an Introduction by F. C. Linn, the following papers are included: " Lubrication problems and requirements of gas turbine equipment," F. C. Linn; " Operating experience and problems relative to lubricating systems of steam turbine sets for utilities," V. F. Estcourt; " Specific problems pertaining to lubrication of industrial turbines," A. S. Morrow; " Lubrication of marine turbine propulsion equipment," F. S. Jones.

Proceedings: Institution of Mechanical Engineers, January–December 1949. London: The Institution. Pp. ix + 608.

Papers include " The application of free jets to the mixing of fluids in bulk," by J. Fossett; " Mechanical engineering in the chemical industry," by F. H. Bramwell; " Some current types of marine diesel engine," by C. C. Pounder; " The measurement of kinetic boundary friction, or the experimental investigation of ' oiliness,' " by J. R. Bristow; " Synopsis of papers on the flow of fluids," by H. E. Rose; and " Further researches in fluid flow through beds of granular material," by H. E. Rose.

Proceedings, 29th Annual Convention, Natural Gasoline Association of America. Tulsa: The Association. Pp. 69.

B.S. 1428: Part A1: 1950. Carbon and Hydrogen Combustion Train. Pregl Type. (Microchemical apparatus.) London: British Standards Institution, 1950. Pp. 21. 3*s*. net, post free.

B.S. 1428: Part D2: 1950. Wash Out Pipettes. (Microchemical apparatus.) London: British Standards Institution, 1950. Pp. 13. 2*s*. net, post free.

B.S. 1428 : Part D3 : 1950. Micro-nitrometers. Pregl Type. (Microchemical apparatus.) London : British Standards Institution, 1950. Pp. 11. 2*s*. net, post free.

B.S. 1660 : Part 1 : 1950. Self-holding Tapers. London : British Standards Institution, 1950. Pp. 20. 5*s*. net, post free.

B.S. 1669 : 1950. Industrial Perforated Plates. London : British Standards Institution, 1950. Pp. 10. 2*s*. net, post free.

A.S.T.M. Standards in Petroleum Products and Lubricants. American Society for Testing Materials. Philadelphia, Pa. : The Society, 1950. Pp. 764 + xviii. $5.50. Obtainable also from the Institute of Petroleum, £2 10*s*., post free.

This latest compilation of A.S.T.M. Standards on Petroleum Products and Lubricants (with Related Information) brings together most of the A.S.T.M. standards, test methods, and specifications widely used in this field. (The tests for knock rating of engine fuels and certain sampling and volume-measuring standards are issued in special manuals and not included in this compilation.)

Prepared by A.S.T.M. Committee D-2 on Petroleum Products and Lubricants, this edition gives in their latest form 125 A.S.T.M. standards, including 112 test methods; eight specifications; three lists of definitions relating to petroleum, specific gravity, and rheological properties of matter; two tentative recommended practices for the purchase of uninhibited mineral oil for use in transformers and in oil circuit-breakers, and for designating significant places in specified limiting values; and other material.

The standards are grouped in broad classifications of petroleum products, and new material includes tentative test methods for : askarels; boiling-point range of polymerization-grade butadiene; carbonyl content of butadiene; factors and tables for volume correction and specific-gravity conversion of liquefied petroleum gases; phosphorus in lubricating oils, lubricating-oil additives, and their concentrates; apparent viscosity of lubricating greases; acidity of residue from distillation of gasoline and petroleum solvents; water tolerance of aircraft fuels; analysis of 60 octane number *iso*-octane normal heptane A.S.T.M. knock test reference fuel blends by infra-red spectrophotometry; 1 : 3-butadiene in C_4 hydrocarbon mixtures by ultra-violet spectrophotometry; heptane number, kauri-butanol value, and nitrocellulose diluting power of hydrocarbon solvents.

Appendices include, in addition to the report of Committee D-2 on Petroleum Products and Lubricants, proposed methods of test for : hydrocarbon-type analysis of diesel fuels by silica-gel adsorption; bromine number of petroleum distillates (colour indicator and electrometric methods); refractive index and refractive dispersion of hydrocarbon liquids; density of knock test standard normal heptane and *iso*-octane; pour-stability characteristics of winter-grade motor oils; reduced pressure distillation of petroleum products; and proposed definitions and specifications for tractor fuels. There are also recommendations on the form of A.S.T.M. methods of test for petroleum products and lubricants; list of proposed methods prepared by Committee D-2 and published as information prior to 1950 and of other A.S.T.M. publications on petroleum products and lubricants; and regulations governing A.S.T.M. Committee D-2.

APPLICATIONS FOR MEMBERSHIP OR TRANSFER

JANUARY 1951

The following have applied for admission or transfer to the Institute. In accordance with the By-laws, the proposals will not be considered until the lapse of at least one month after the publication of this *Journal*, during which time any Fellow, Member, Associate Fellow, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of the candidate.

The object of this information is to assist the Council in grading the candidate according to the class of membership.

The names of candidates' proposers and seconders are given in parentheses.

Applications for Membership

BROWN, David Deverton, student, Birmingham University. (*F. H. Garner ; F. Morton.*)

BURGESS, Henry George, assistant mechanical engineer, Trinidad Petroleum Development Co. Ltd. (*J. Westbury ; J. S. Collcott.*)

BURJORJEE, Hirjee Rustom, chemist, Anglo-Iranian Oil Co. Ltd. (*L. A. Wilshere ; G. Pearce.*)

CALDWELL, Robert Finney, general manager, Esso Standard Oil (Antilles) S.A. (*P. E. T. O'Connor ; W. Madden.*)

CROWLEY, John, export manager, Curran Oils Ltd. (*B. R. Curran ; G. A. S. Turnbull.*)

DANIEL, Sydney George, research chemist, "Shell" Refining & Marketing Co. Ltd. (*C. B. Davies ; C. D. Brewer.*)

DE LA COVA, Carlos Perez, oil adviser, Venezuelan Embassy. (*S. J. M. Auld ; T. Dewhurst.*)

DIMITRIU, Constantin A., chief exploitation engineer, United British Oilfields Trinidad Ltd. (*J. L. Andrews ; J. Grant.*)

FREEBORN, Albert Sydney, research chemist, Dussek Bros. & Co. Ltd. (*V. Biske ; A W. Thompson.*)

GREW, John Ernest, student, Birmingham University. (*F. H. Garner ; F. Morton.*)

HATL, Rodney Thomas William, lecturer, Dept. of Chemical Engineering, Birmingham University. (*F. H. Garner ; F. Morton.*)

HOLMES, Jeffrey Bryan, director, Messrs. T. Moscrop & Co. Ltd. (*E. R. Wilson ; G. M. Davies.*)

JENKINS, Thomas Edmond, development chemist, National Oil Refineries Ltd. (*J. A. Green ; E. J. Horley.*)

MACKIAN, Joseph, sales supervisor, Curran Oils Ltd. (*B. R. Curran ; G. A. S. Turnbull.*)

MILES, Peter Frederick, technical sales representative, Monsanto Chemicals Ltd. (*J. M. Nuttall ; G. Sell.*)

NICOLL, Harry Good, acting chief engineer, Shell-Mex Brazil Ltd. (*G. C. Carr ; W. R. Davies.*)

REID, William Donald, student, Dept. of Chemical Engineering Research, Birmingham University. (*F. Morton ; F. H. Garner.*)

STEVENSON, Stanley, representative, Curran Oils Ltd. (*B. R. Curran ; G. A. S. Turnbull.*)

Transfers

BEVAN, Henry George Moore, division transportation supervisor, Texas Petroleum Co. (*J. S. Parker ; R. L. S. Panisset.*) (*Associate Fellow to Fellow.*)

COBLEY, Ronald Charles, assistant process superintendent, Manchester Oil Refinery Ltd. (*J. Wood-Mallock ; G. H. Harries.*) (*Associate Member to Associate Fellow.*)

DOULTON, Peter Duke, director, Messrs. Matthew Hall & Co. Ltd. (*C. A. P. Southwell ; E. C. Masterson.*) (*Member to Fellow.*)

GREEN, Raymond George, chemist, "Shell" Refining & Marketing Co. Ltd. (*W. R. P. Hodgson ; D. L. Samuel.*) (*Associate Fellow to Fellow.*)

JONES, Michael Trevor Balch, process engineer, Vacuum Oil Co. Ltd. (*H. M. Davies ; G. Sell.*) (*Student to Associate Fellow.*)

MORRIS, Dennis Michael, petroleum engineer, Trinidad Leaseholds Ltd. (*Student to Associate Member.*)

NEW MEMBERS

The following elections have been made by the Council in accordance with the By-laws.

Elections are subject to confirmation in accordance with the By-laws.

As Fellows

BUREAU, A. C.
MATTHEWS, T. H.
MAYO, F.
VARCOE-COCKS, D.

As Associate Fellows

AILAWADI, G. D.
BROOKS, D. G.
DA CUNHA BAHIANA, J. E.
DARNELL, A. R.
DRYSDALE, C. D.
EL BADRI, A.
GUPTA, R. K.
HUNT, A. D.
KING, G.
ROGERS, M. J. L.
SAXENA, S. D.
SINGH, R.
VAN DER MERWE, C. C.
VENKATACHALAM, E.
WILSON, I. H.

Transferred from Students to Associate Fellows

BAND, C. H.
RANKIN, P. A.

As Associate Members

DICKESON, R. V.
SECKER, R. L.

As Student

BALDWIN, J. G. M.

CORRECTION

BROOKS, DOUGLAS GORDON. In the *Journal* for November 1950, Mr Brooks' employers were given as "The Vacuum Oil Co. Ltd." This should have read "The Vacuum Oil Co. of South Africa, Ltd."

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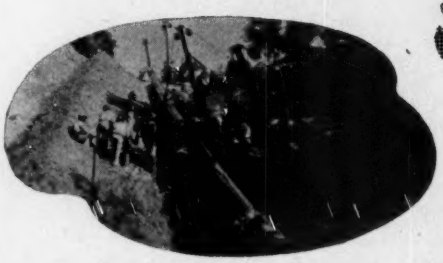

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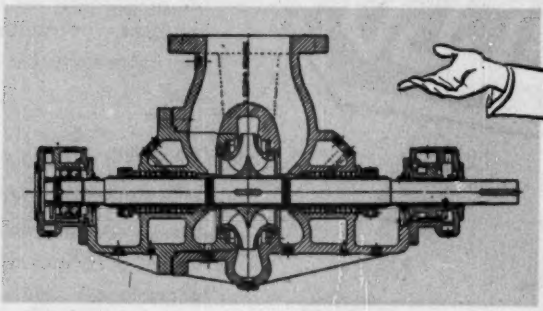

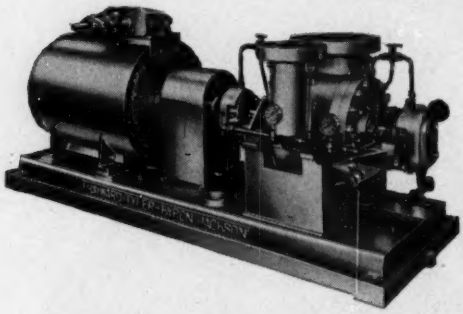

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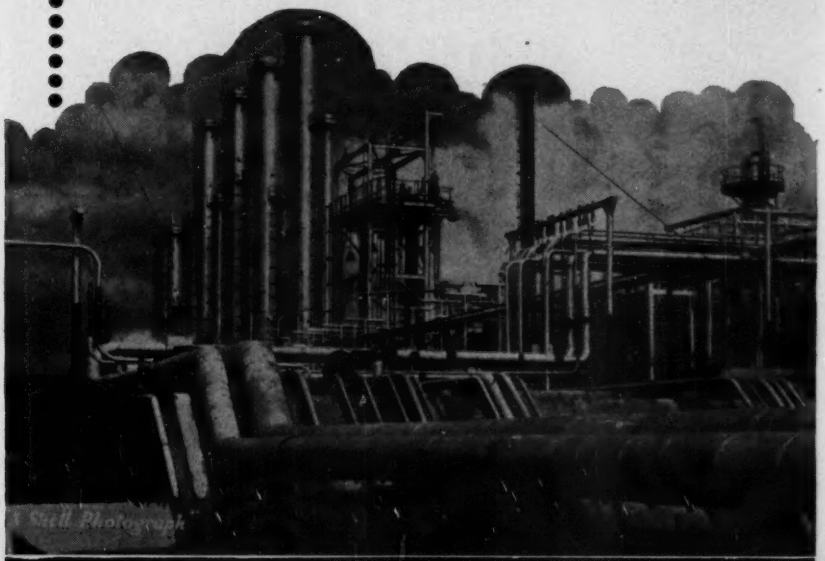

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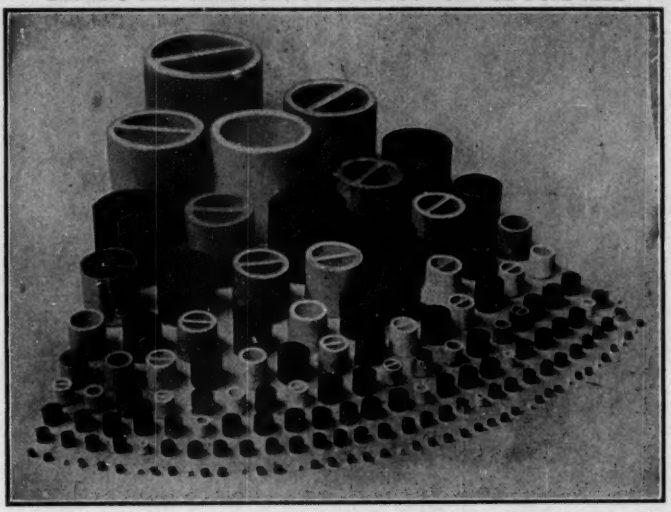

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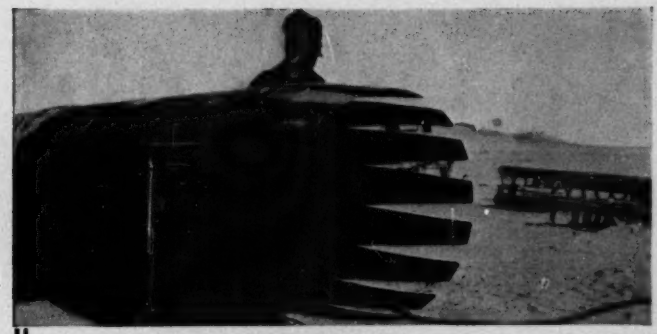

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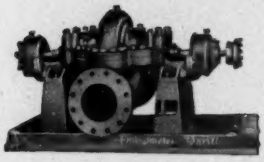

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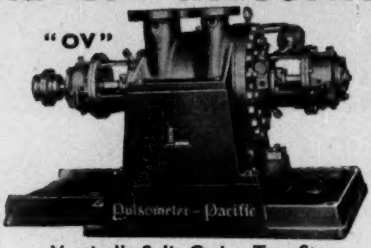

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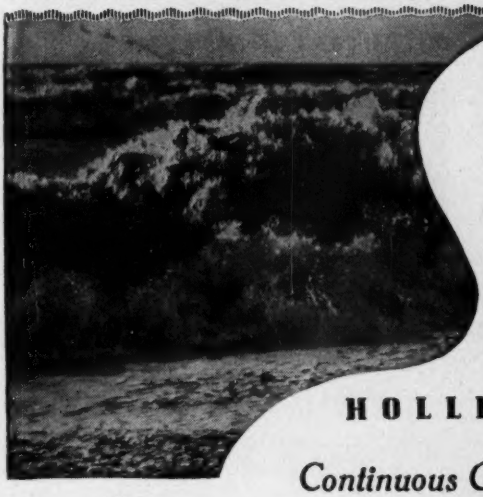

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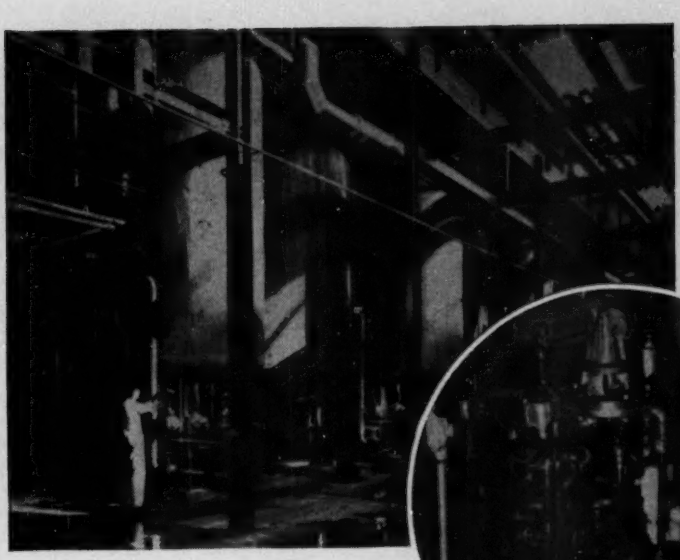

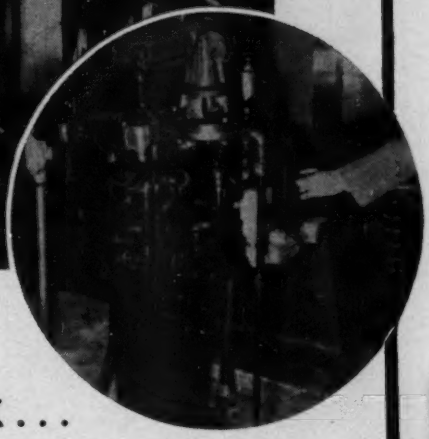

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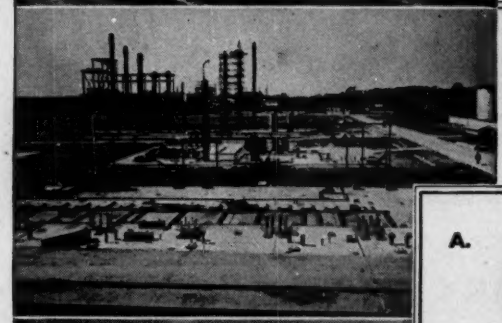

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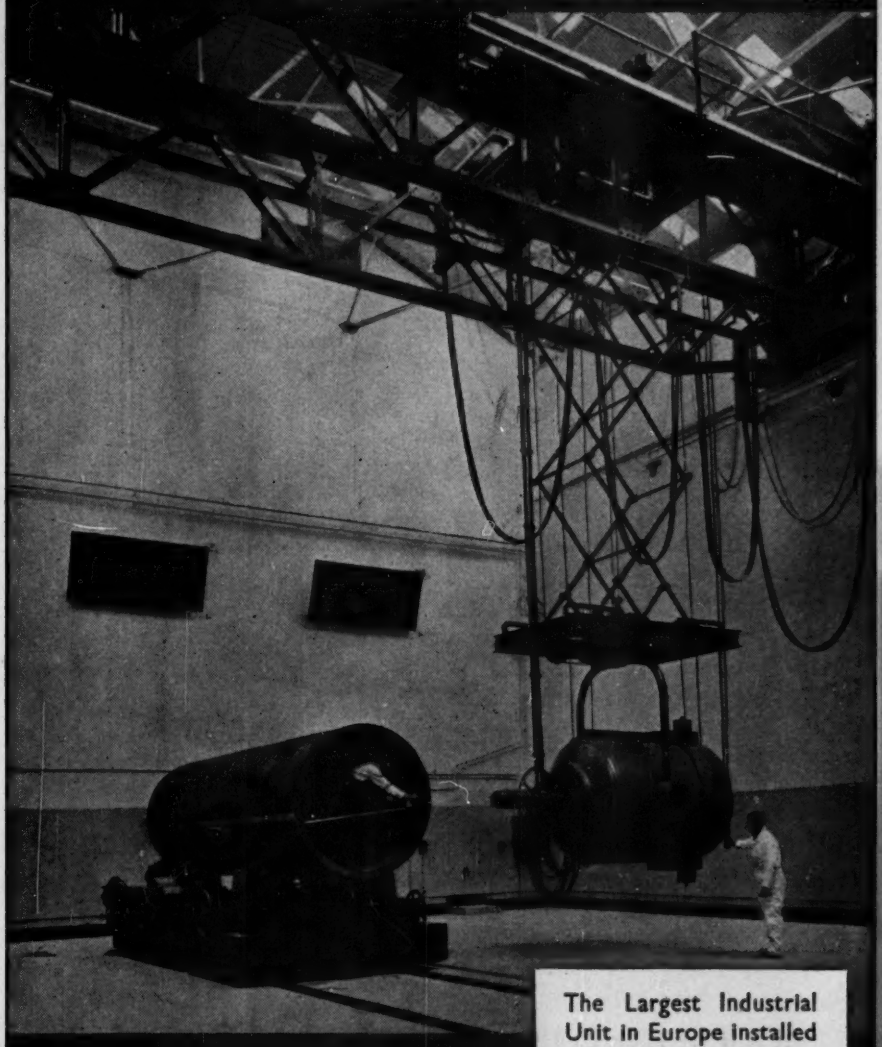

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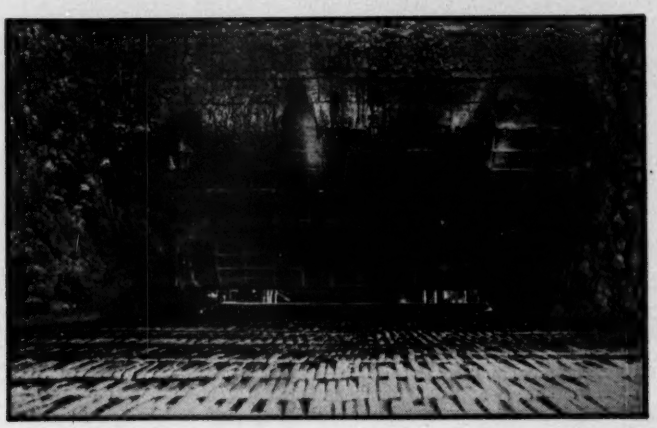

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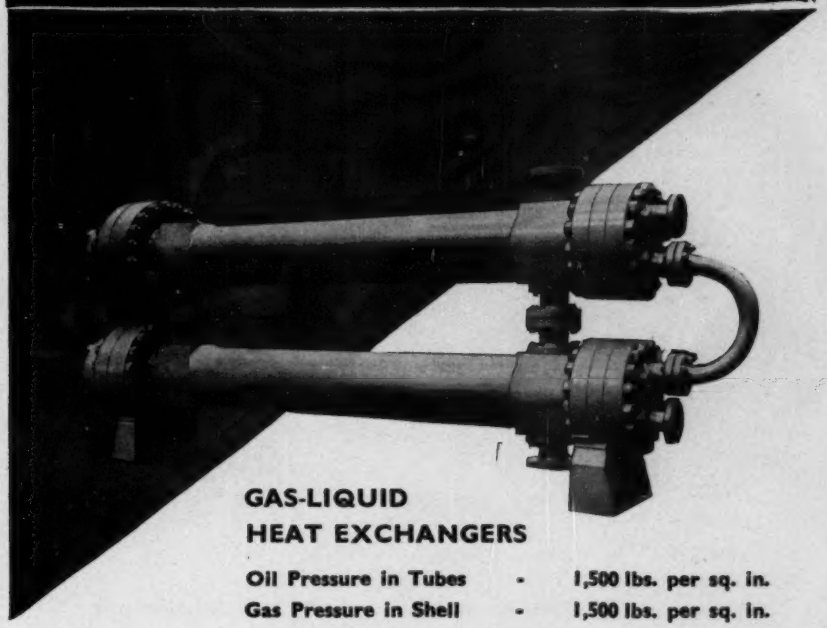

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